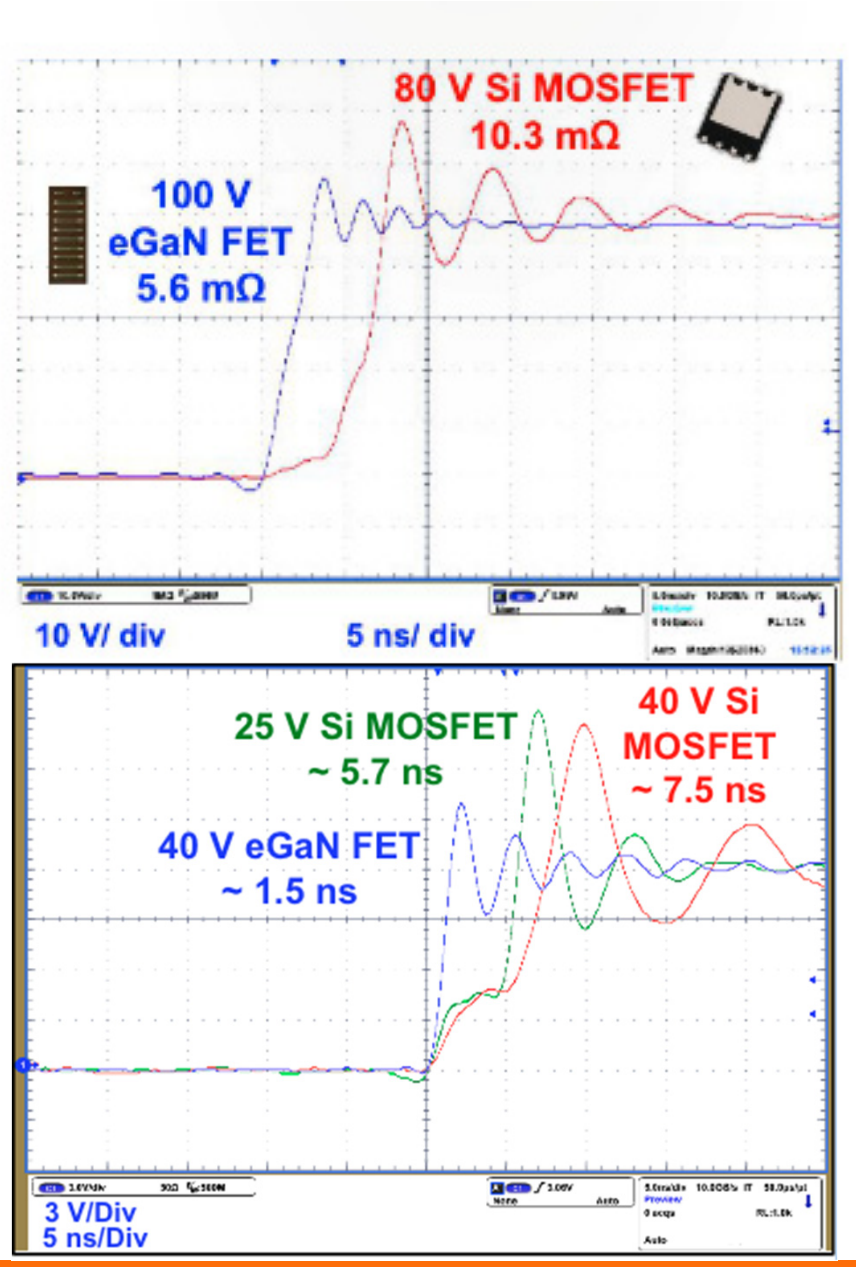
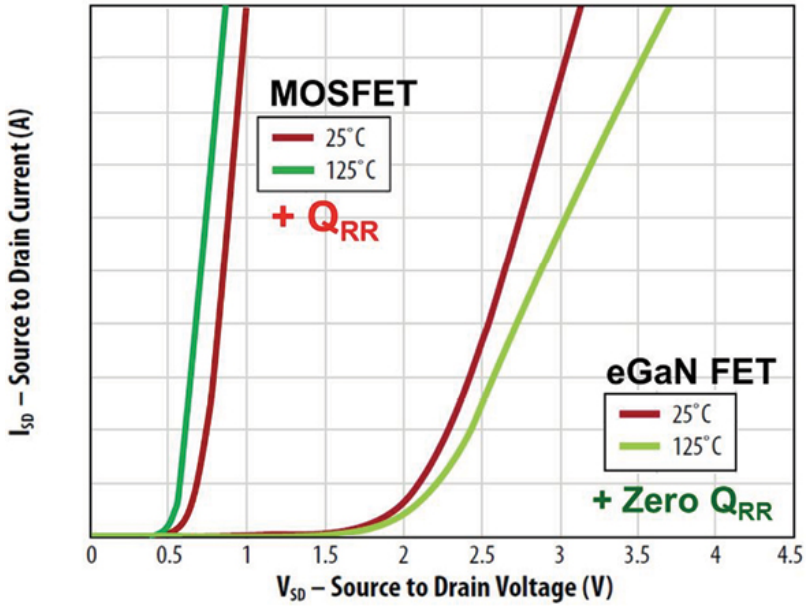
Designing with GaN

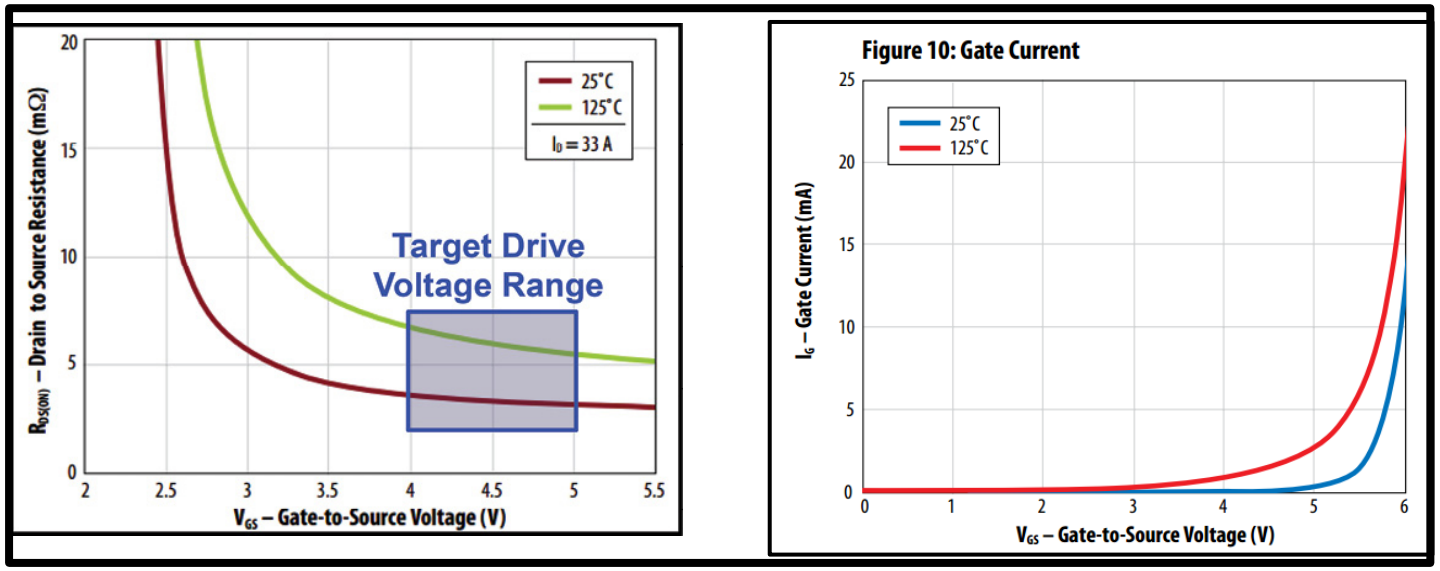
- Because of high electric breakdown field and high electron velocity, GaN devices with comparable R_{on} can be significantly smaller and switch must faster.
- Need **very** good layout to prevent ringing from causing overvoltage and device failure.

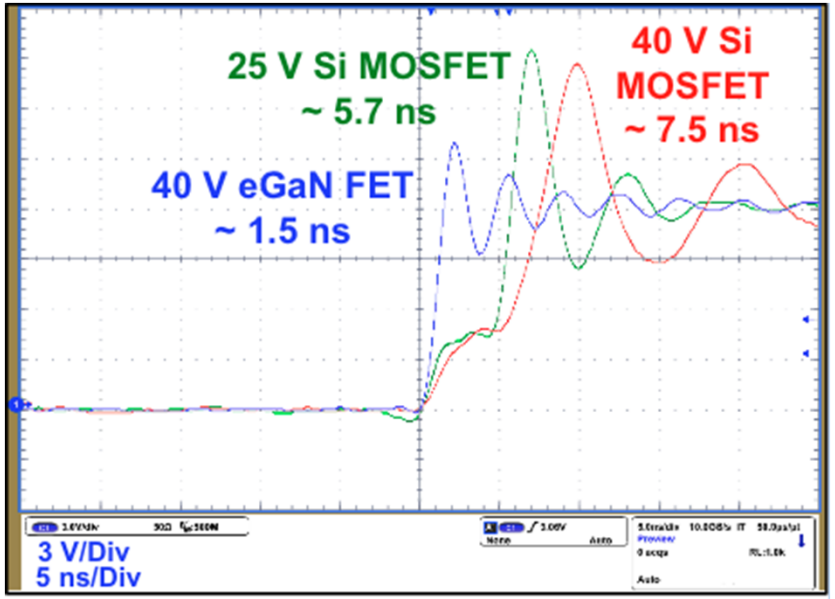


GaN Design Issues

1. Reverse conduction mechanism
2. Sensitivity to parasitics
3. Gate robustness
4. Small size -> Thermal limitations

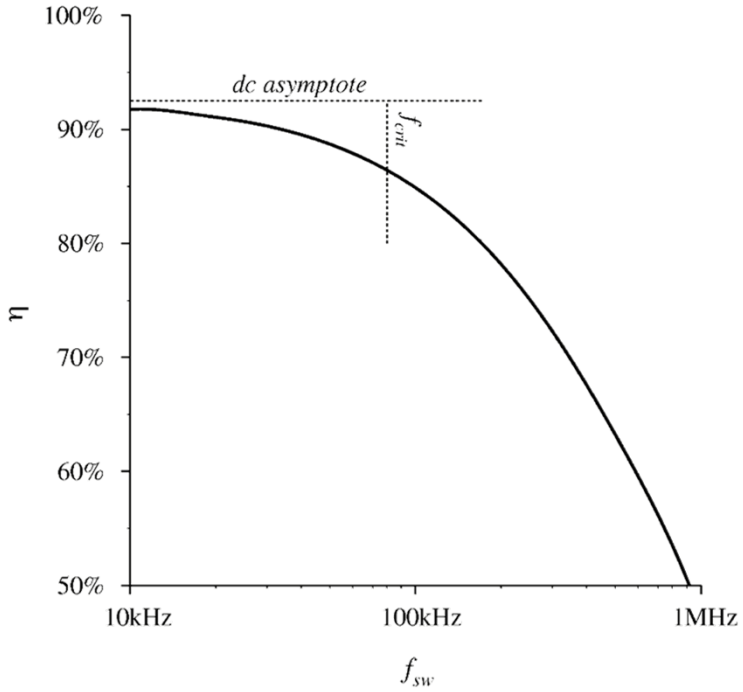




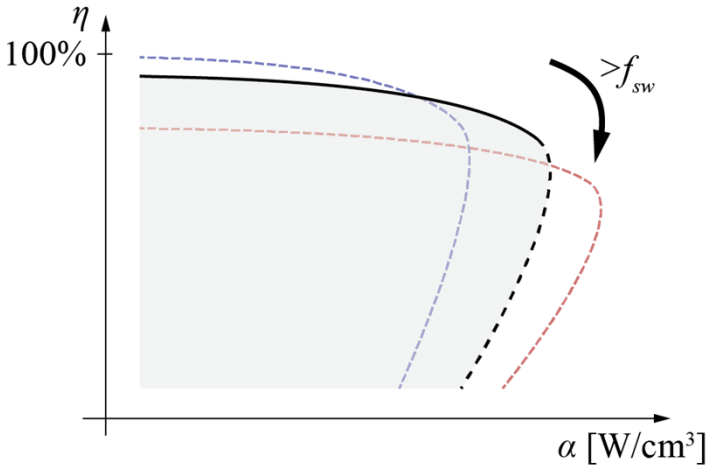


Converter Efficiency Vs. f_s

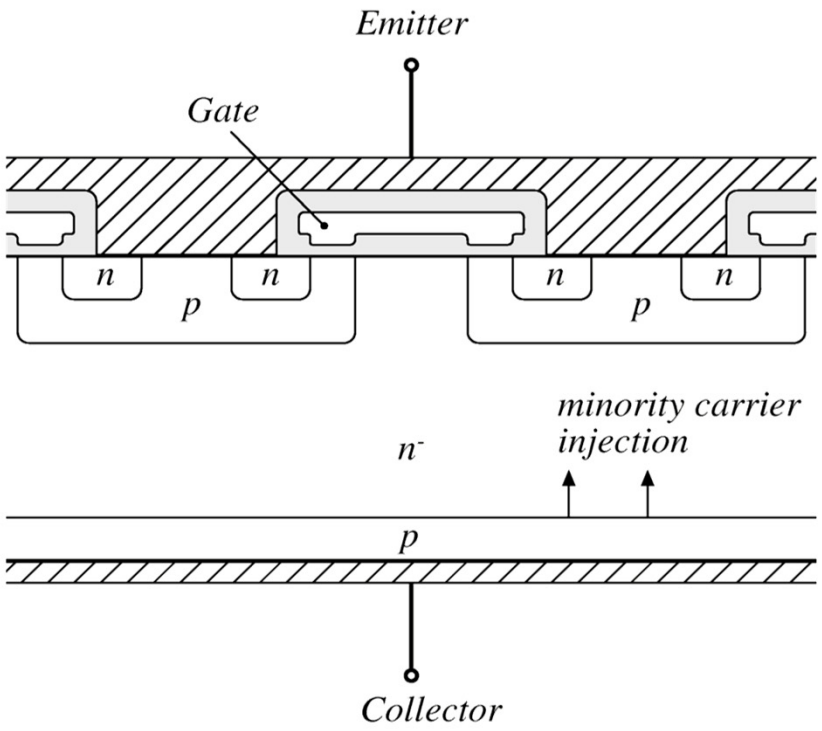
$$P_{loss} = P_{cond} + P_{fixed} + W_{tot} f_{sw}$$



Converter Optimization



Insulated Gate Bipolar Junction Transistor



- A four-layer device
- Similar in construction to MOSFET, except extra p region
- On-state: minority carriers are injected into n^- region, leading to conductivity modulation
- compared with MOSFET: slower switching times, lower on-resistance, useful at higher voltages (up to 1700V)

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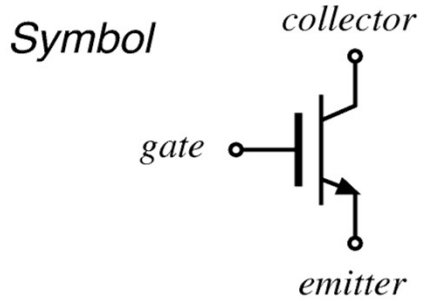
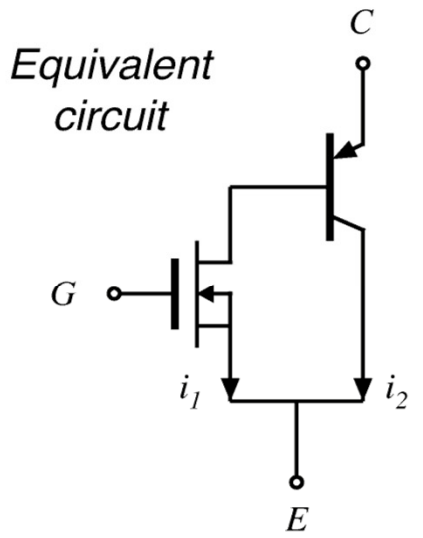
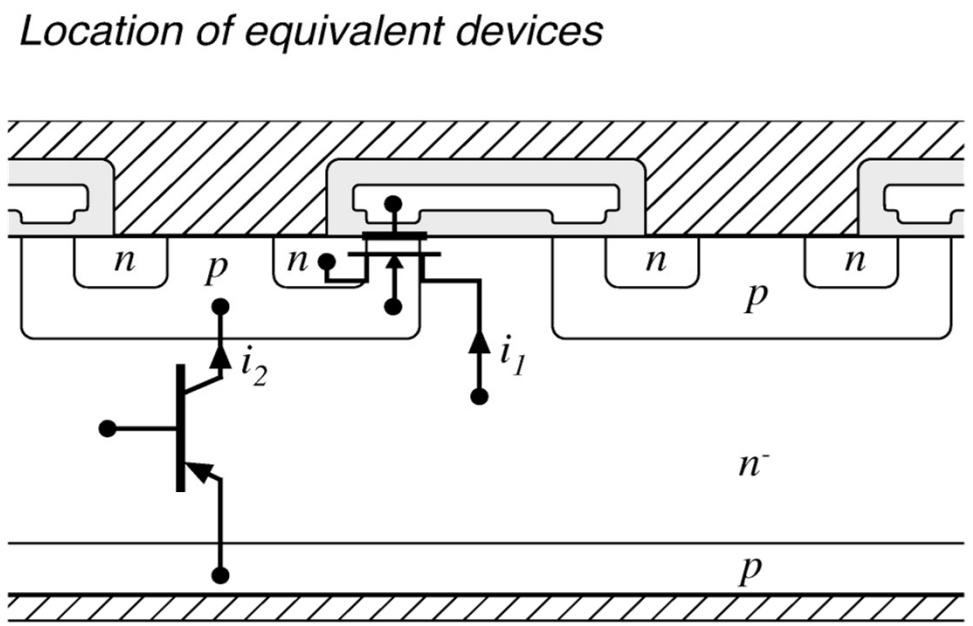
The IGBT







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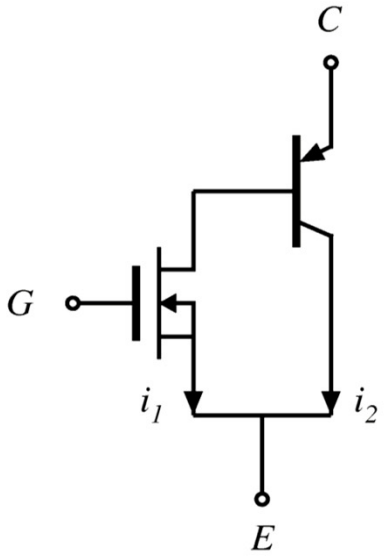
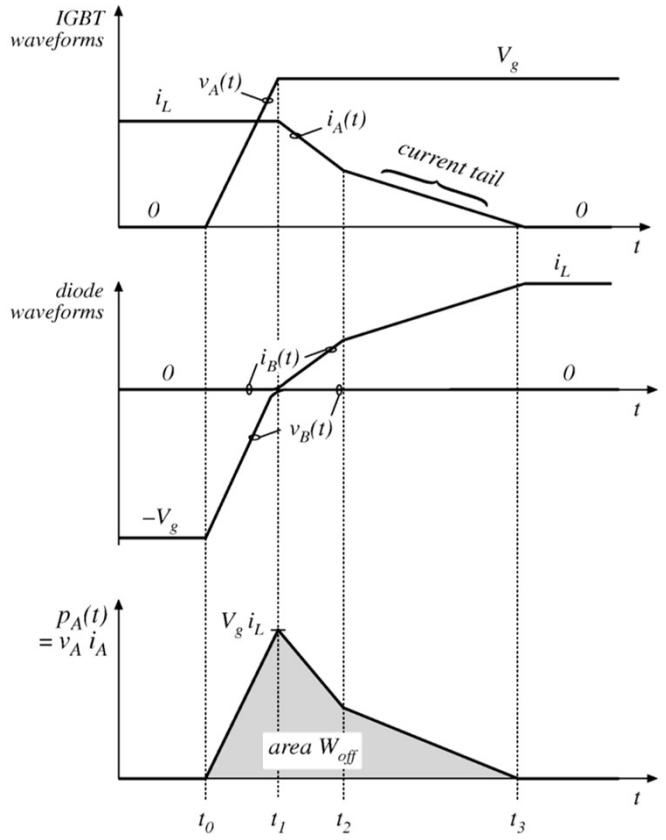
IGBT: Current Tailing





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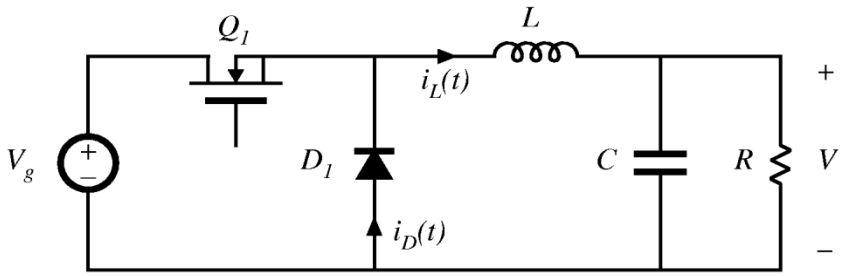
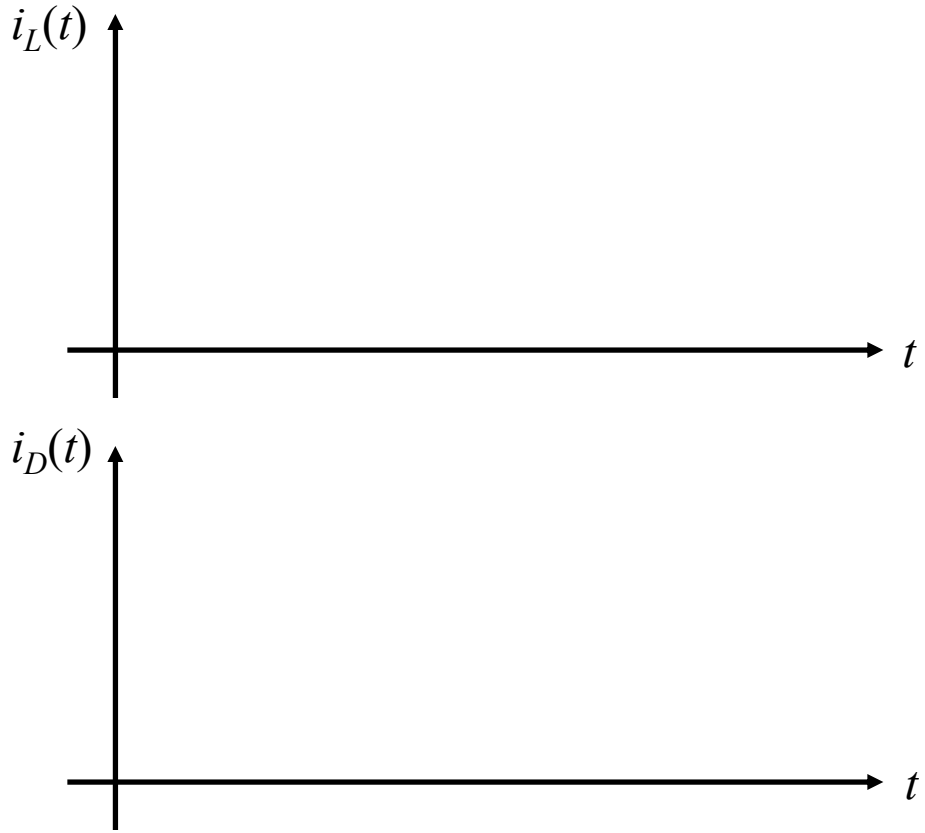
Chapter 5

THE DISCONTINUOUS CONDUCTION MODE

Buck Converter Example





DCM/CCM Modes of Operation