Tektronix

Wide Band Gap for Power Converters (SiC / GaN vs Si)

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Agenda

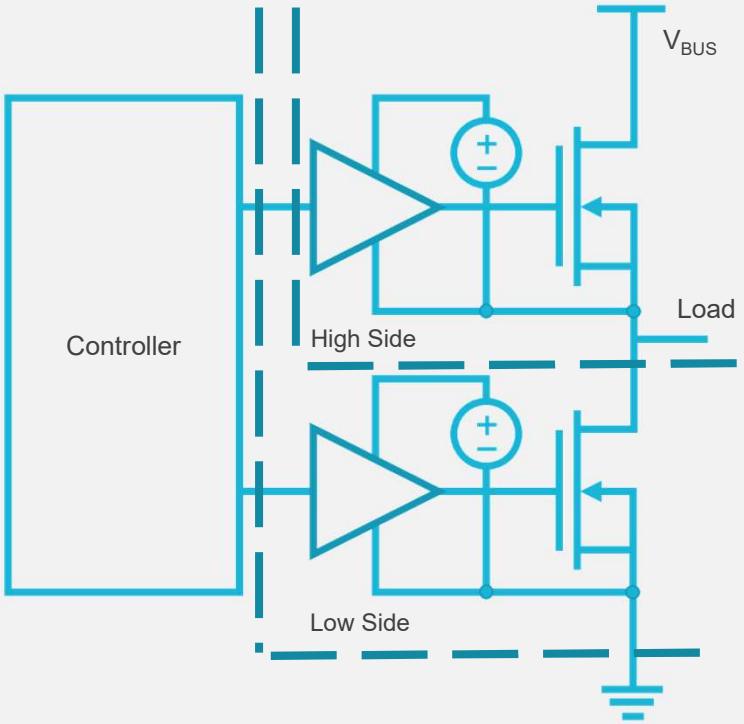
- Introduction - Power Challenges
- Wide Band Gap (GaN / SiC)
- Measurements
  - Challenges
  - Solutions
- Summary

Why Sic and Gan vs Si?

Traditional Circuit Gets Complicated

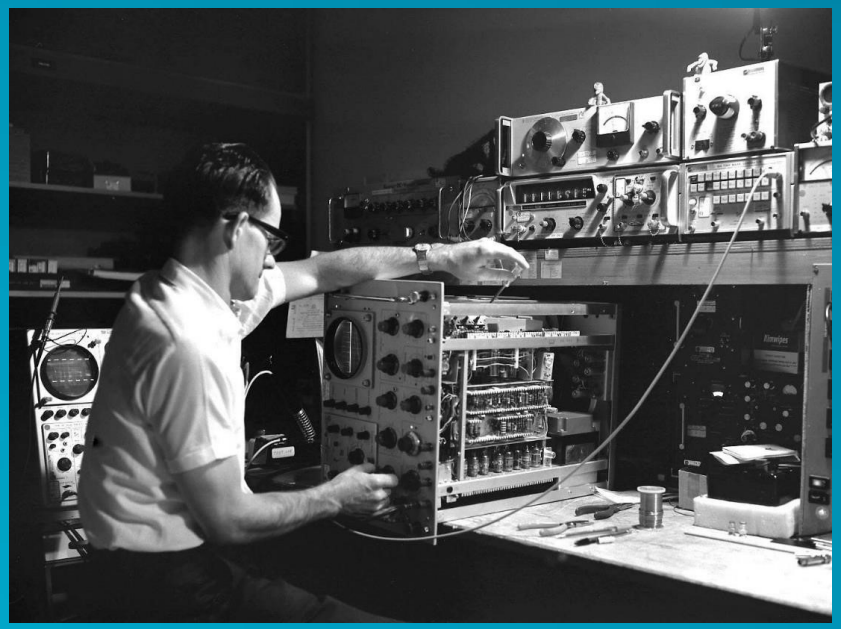
THE HALF BRIDGE

- Demands for higher efficiency
- Increased voltages and currents
- Smaller size
- Environmental tolerance
- Cost
- Reliability



Technology is Changing

Wide Band Gap (GaN / SiC)



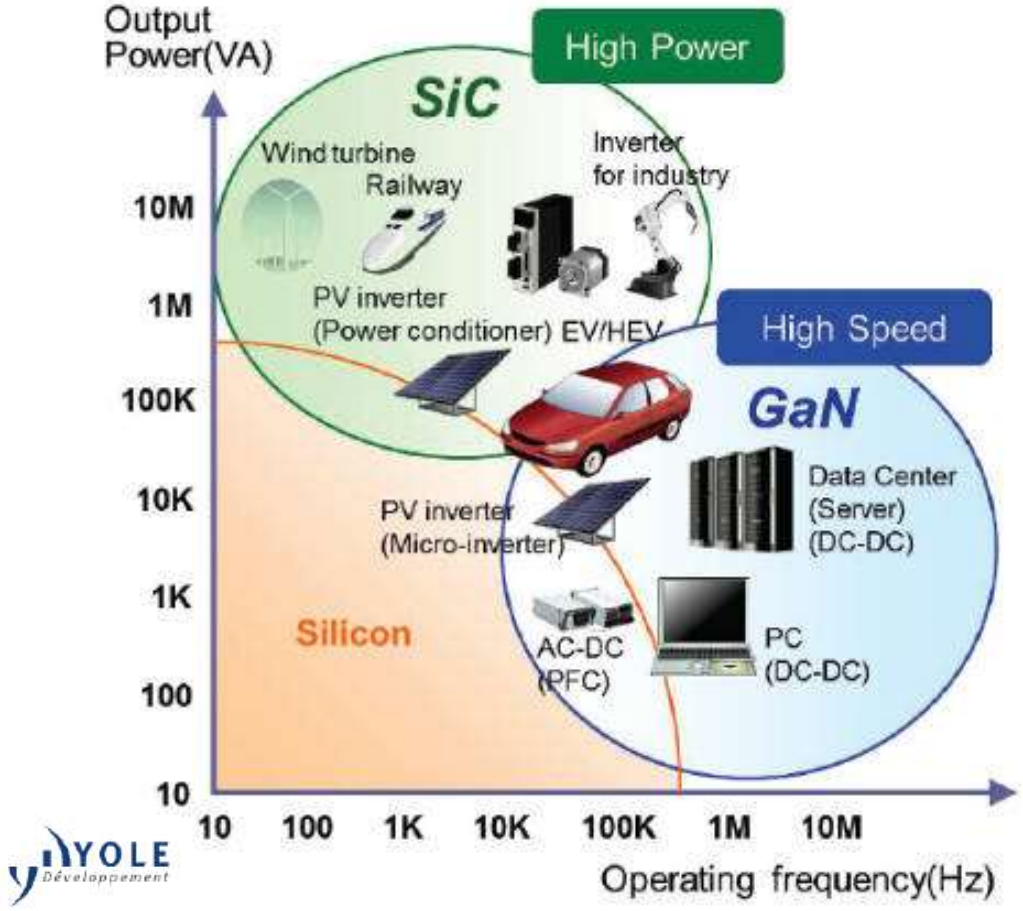
Introduction of Wide Band Gap (GaN / SiC)

- GaN: Gallium Nitride
- SiC: Silicon Carbide

Compared to conventional semiconductor materials like Silicon (Si) and Gallium Arsenide (GaAs) wide-bandgap semiconductors allow:

- Operation at much higher voltage/current
- Operation at higher temperatures
- Operation at higher frequencies
- Smaller packaging

Power vs. Switching Speeds

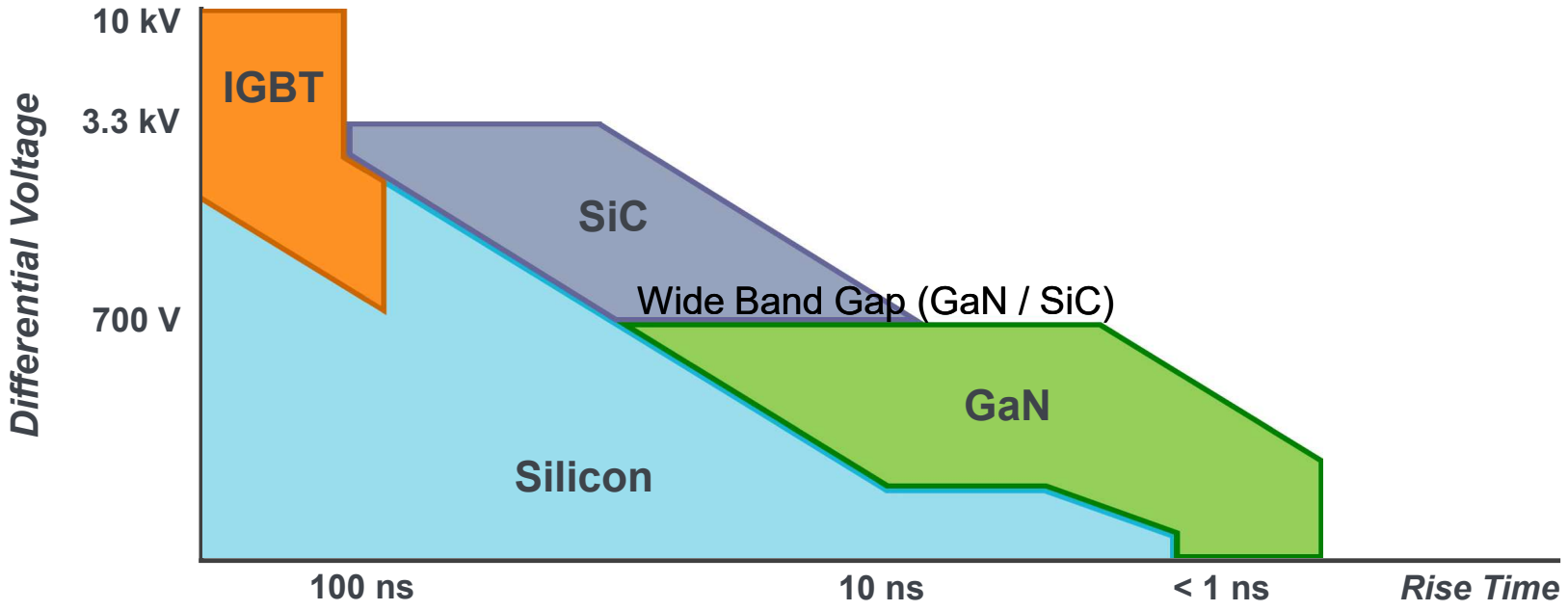


SiC for high power voltages (>1kV) with high current
= niche market

GaN on Si for high frequency at midrange voltages (<1kV, up to 100A)
= mass market

More Than Just Switching Frequency

FOCUSING ON RISETIMES



Measurement Challenges

Wide Band Gap: Measurement Challenges

Fast high voltage fast switching

- Common mode rejection

Fast rise times

- Measurement bandwidth

Sensitivity to parasitics

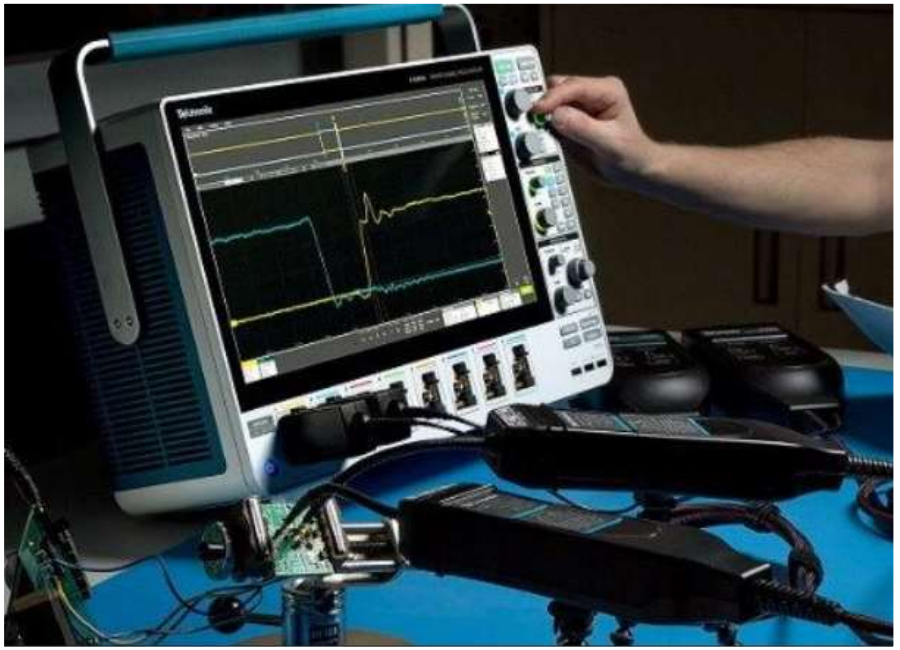
- Measurements that don't effect the design

Accessibility to test points

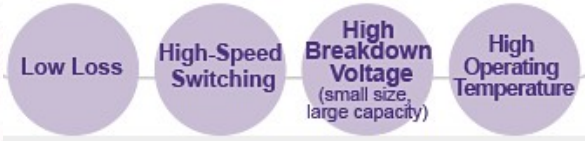
- Connecting to the small model sizes

Safety

- Injury or death



Challenges (headaches) with WBG



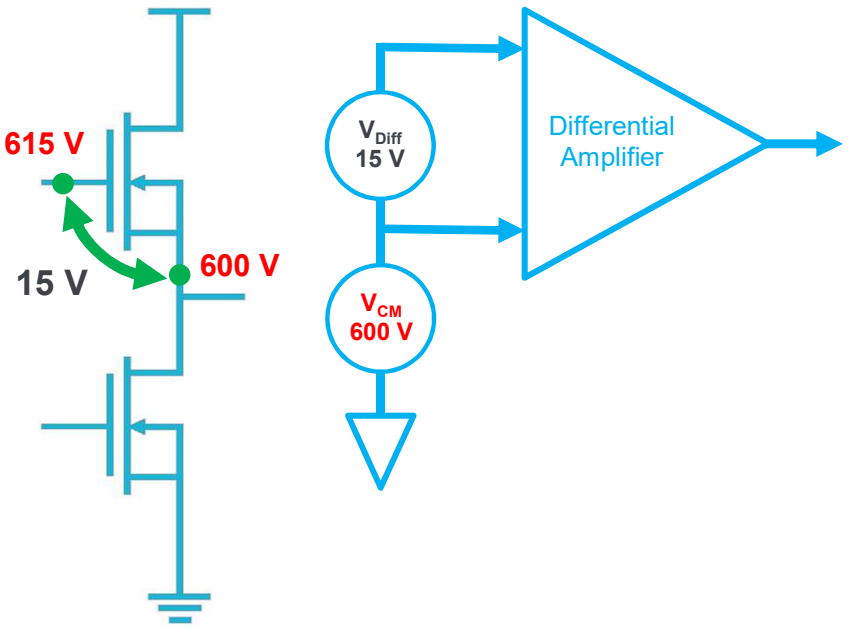
- Alternative packaging materials
- EMI
- New designs, new architectures
- PCB layout
- Integration with existing systems or new Gate Driver
- Reliability and Robustness
- $$$

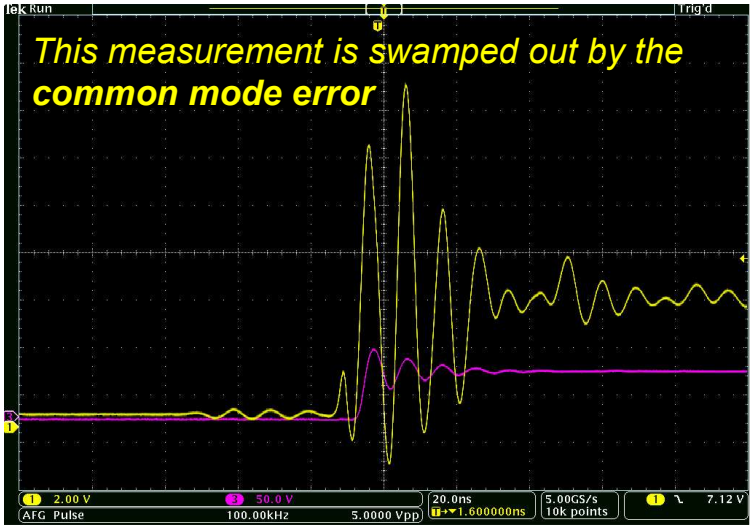
- Simulate & Measure

High Side Measurement Challenge

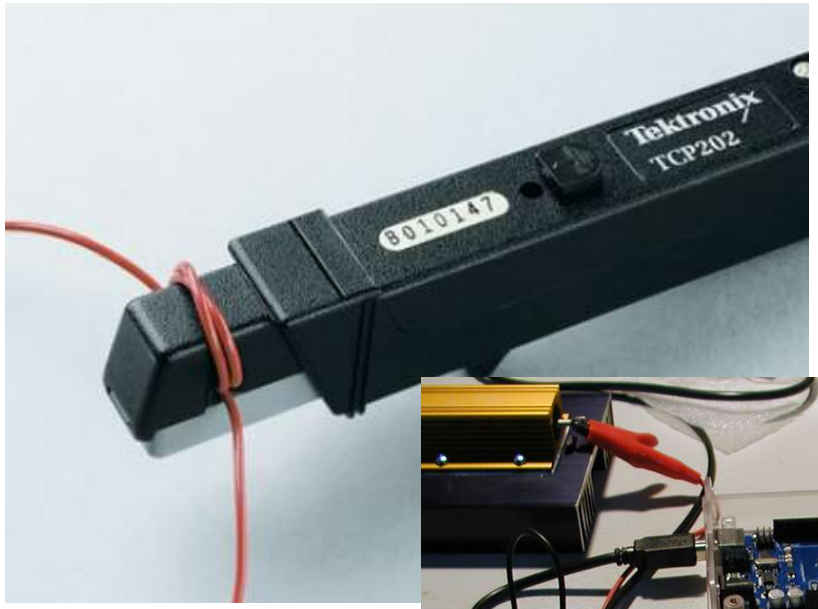
REJECTING COMMON MODE VOLTAGE INDUCTED ERRORS

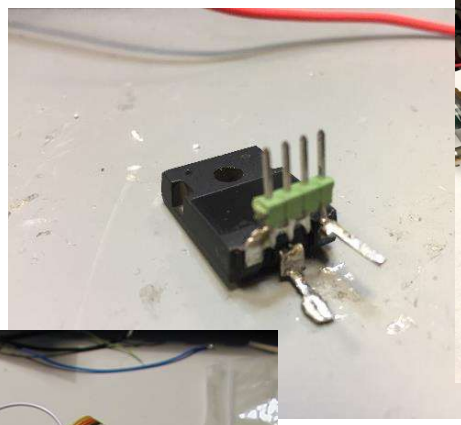
- Isolation from ground
- Fast hi-fidelity measurement system

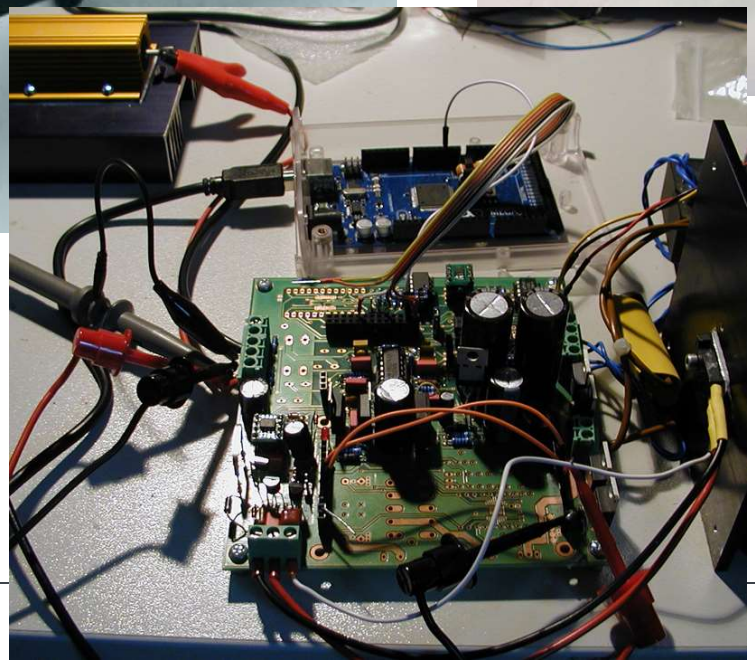




Connections

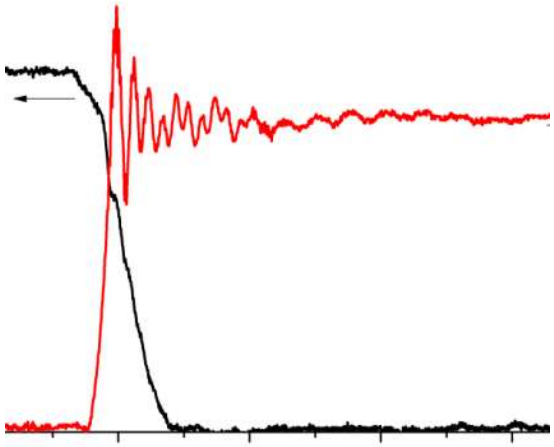


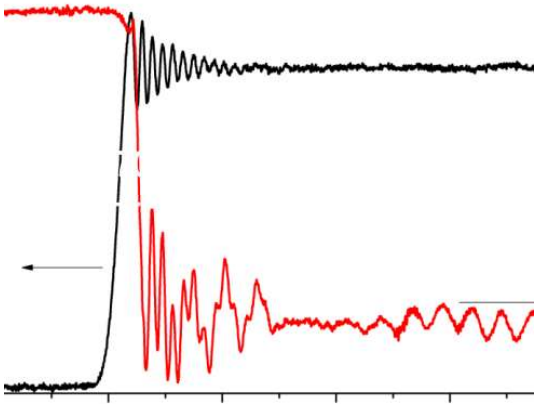


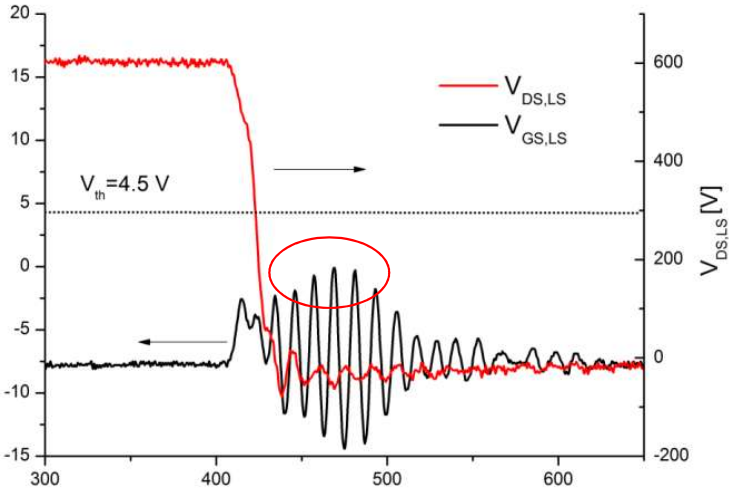


Switching faster (and its consequences)

High Switching Speed (dv/dt and di/dt) - Oscillations







Shoot-through?

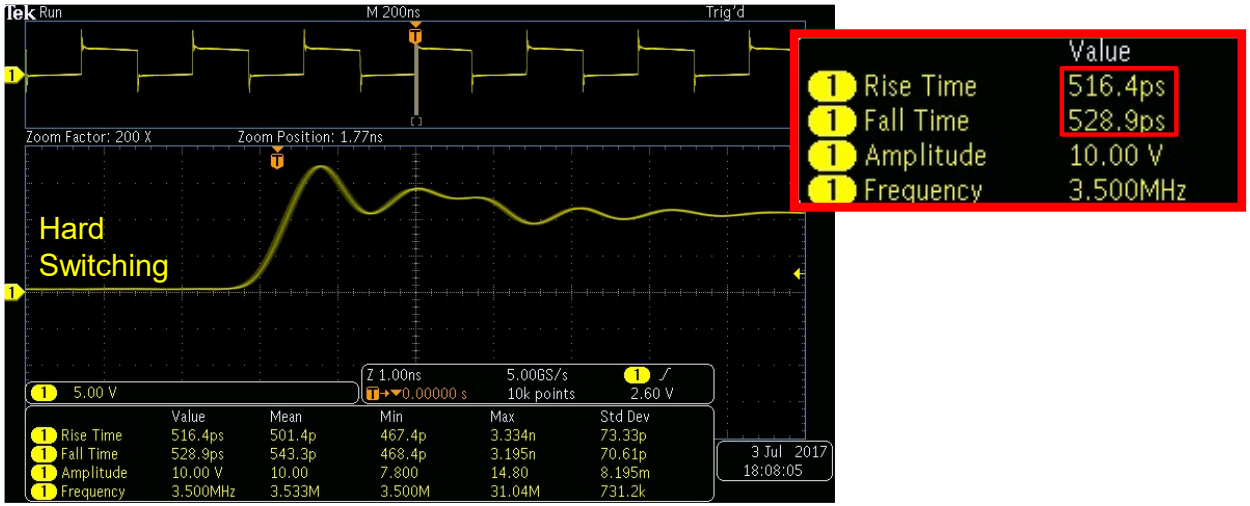
Real? Or measurement artifact?

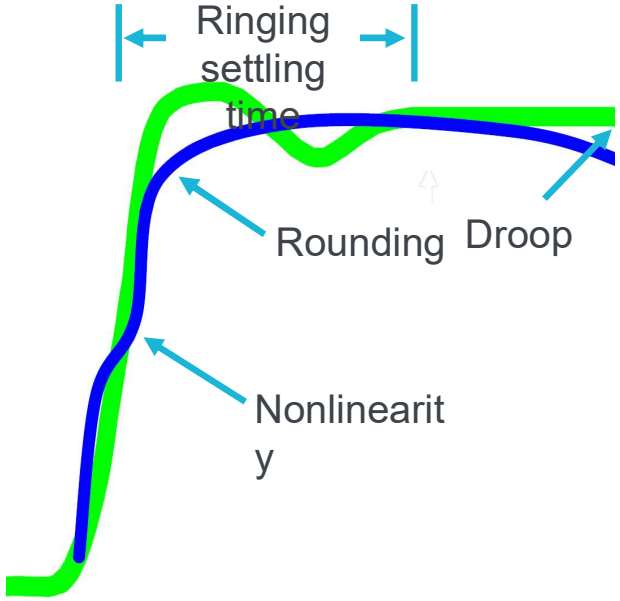
From Infineon Presentation

Bandwidth and Rise Time Considerations

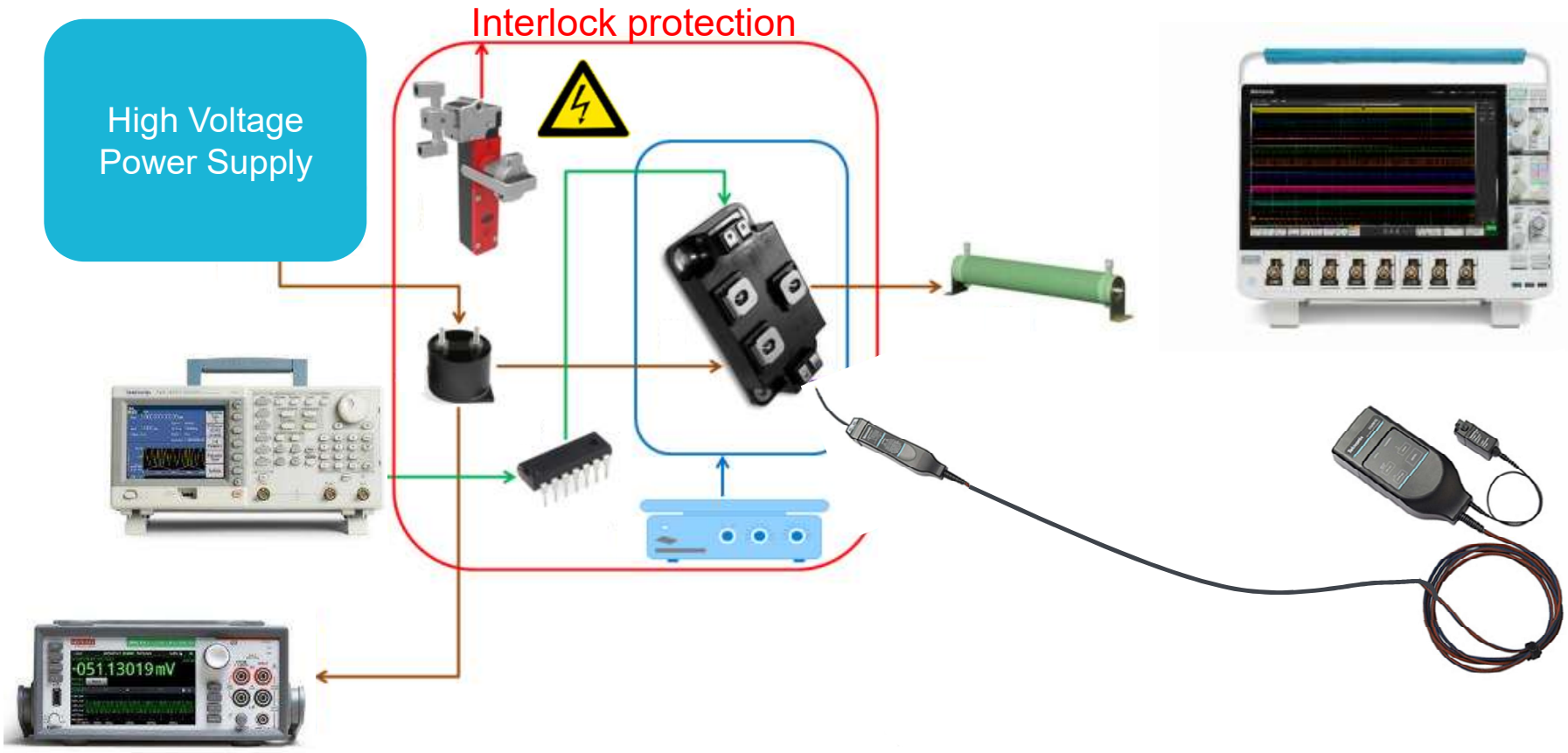
RISE TIME, NOT SWITCHING SPEED

- Edge rate
- Ringing
- Sharp transients

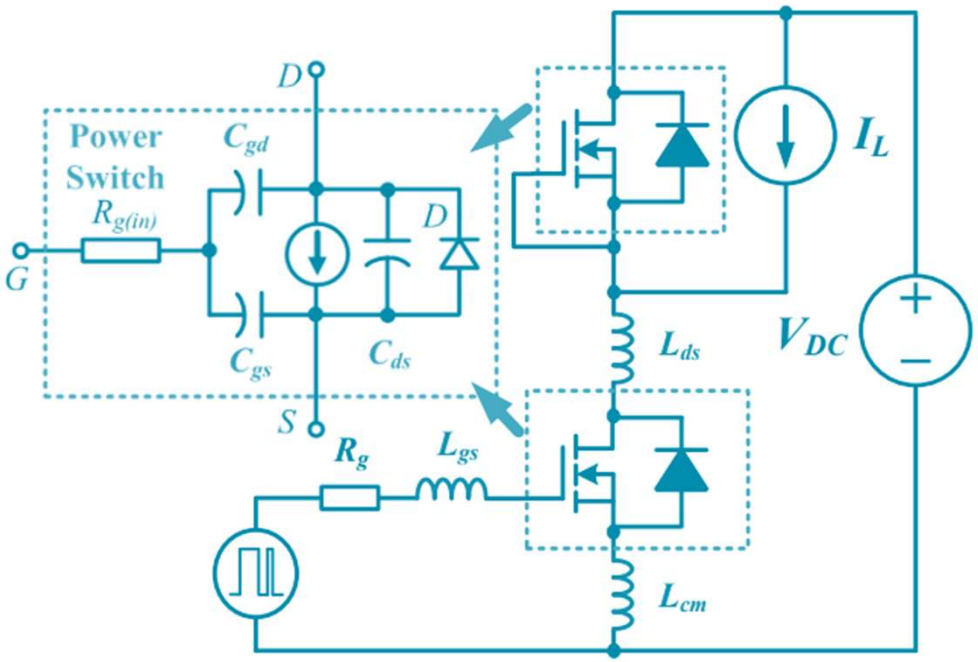


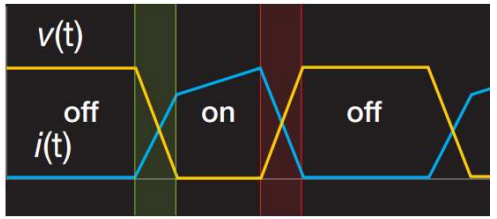


Safety: High voltage precautions

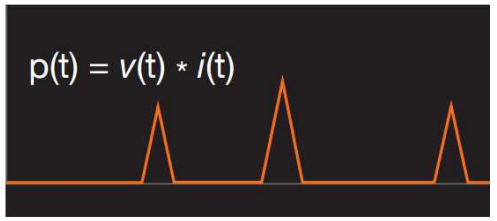


Switching losses and deskew





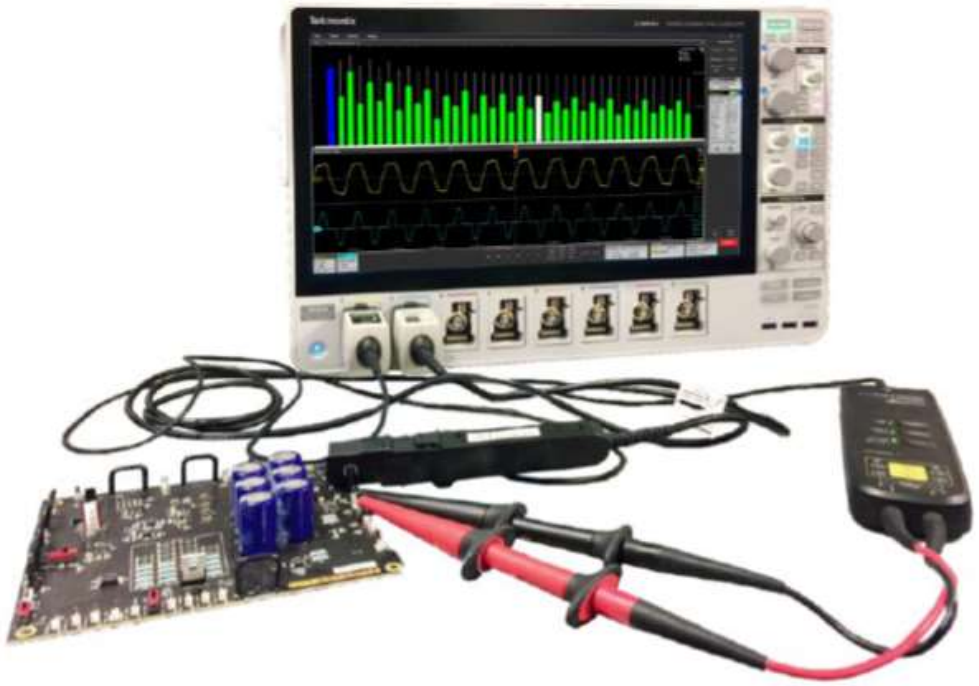
Switch Voltage and Current



Switch Power Loss

Connection Fidelity and Safety

ISSUES WITH THIS SETUP FOR WBG?



SiC Vgs High Side Comparision

Recap in a nutshell

Fast switching -> more parasitic

Reduce current loops, reduce resonances

Accurate measurements rely on using suitable instruments (for that specific measurement)

Instrument starts at the probe tip

Instruments always influence measurements

Stay safe

IsoVu Probing Technology

IsoVu™ technology is a radically new high voltage isolated differential probing solution that gives **Accurate** and **Repeatable** results

- Galvanically isolates the device-under-test from a Tektronix oscilloscope.
- **1 GHz** bandwidth
- World's best common mode rejection
  - Up to **160 dB** (100 million to 1)
- **> 2.5 kV differential** voltage range
- **60 kV** common mode voltage range
- Up to **40 MΩ** input resistance

MMCX For Isovu And Passive Probes

HI-FIDELITY, SAFE, RELIABLE

206-0663-xx

Tip mates directly with MMCX connector

- Shielded, low inductance connection to test points
- Secure hands-free connectivity
- Uses low-cost, industry-standard MMCX connectors
- MMCX connectors may be "tacked on" and used as unplanned test points

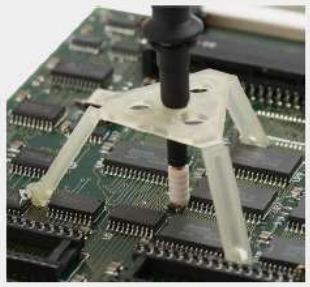
Adapters connect to standard-pitch pins

- Two adapters available for connecting to square pins
  - Spaced on 0.1 in. (2.54 mm) centers
  - Spaced on 0.062 in. (1.57 mm) centers
- Solder tool available for placing 0.062 in. pins

"Y" leads connect to non-standard-pitch pins

- Y-lead adapter works with the 0.1 in. adapter

Tripod mount for added stability

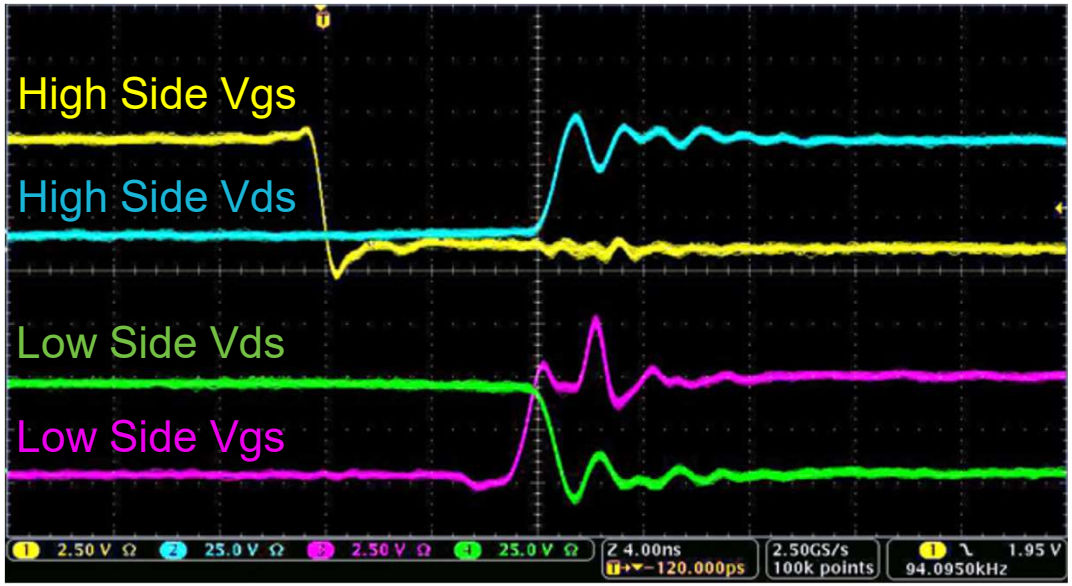


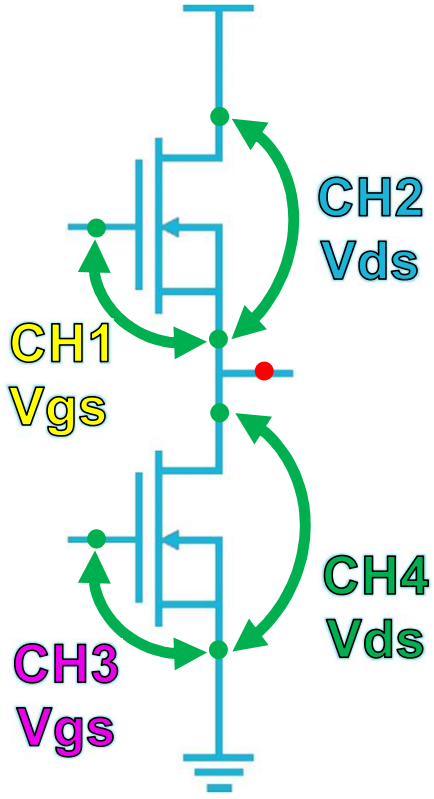
- Tripod mount adds stability to square-pin mounted probes
- Tripod may be glued down to the PCB

Characterize the Entire Switching Circuit

IT IS CRITICAL TO SEE THESE TEST POINTS

- Characterize the gate voltages, Vds, and Is
- Characterize the time alignment of high and low side events
- Optimize and tune switching characteristics





Thank You