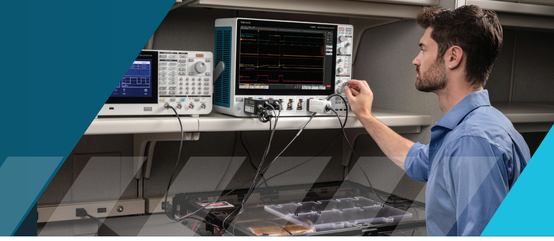
Double Pulse Testing: Characterize Your Wide Bandgap Devices with Confidence

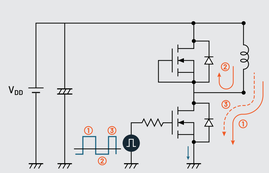


What is Double Pulse Testing?

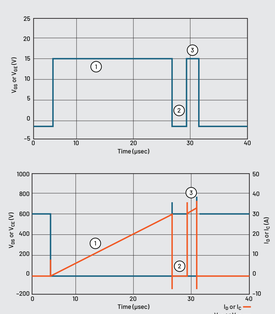
DPT is the industry-standard method for characterizing switching parameters and evaluating the dynamic behavior of Si, SiC, and GaN MOSFETs and IGBTs. This well-established technique has seen renewed importance with the rise of wide bandgap semiconductors like GaN and SiC. DPT provides a controlled, repeatable environment for assessing switching behavior and energy losses, allowing engineers to test at target current levels while minimizing the impact of self-heating on device junctions.

Stages in Double Pulse Testing

1. Establish the target test current (I_D). The width of the first pulse is adjusted to deliver the desired test current through the load inductor.
2. Turn-off of the first pulse and turn-off measurements.
3. Turn-on of the second pulse and turn-on measurements.



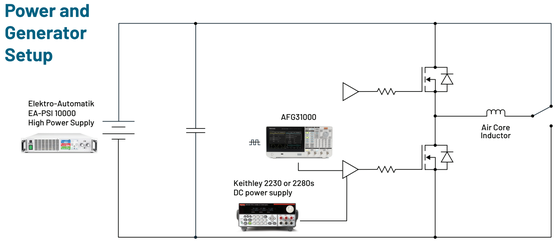
Current flow with MOSFETs as DUTs. The double pulse test can be broken down into three stages, described in the body of this section.

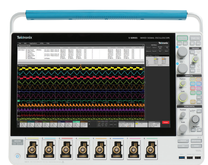


Double pulse test waveforms .The waveform on top shows the signal applied to the gate or gate driver. The signals on the bottom are the corresponding drain current (I_D) and drain-to-source voltage (V_{DS}). Measurements are taken at the transitions between stages 1 and 2, and 2 and 3.

Double Pulse Setups

Power and Generator Setup

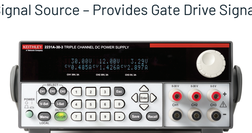




Oscilloscope with DPT Analysis Software – Signal Capture and Analysis

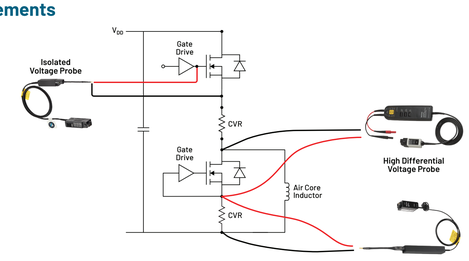
High-Voltage DC Supply – Provides Bus Voltage (V_{DD})

Signal Source – Provides Gate Drive Signal

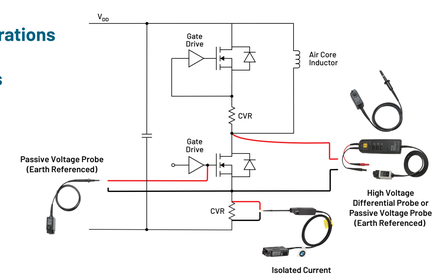


Low-Voltage DC Supply – Powers Gate Drive Electronics

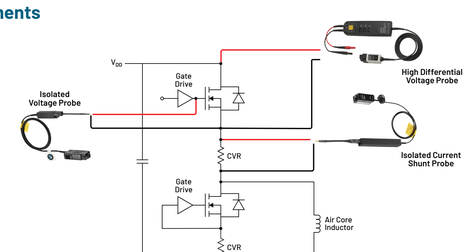
Probe Configurations for Reverse Recovery Measurements



Probe Configurations for Low-Side Measurements



Probe Configurations for High-Side Measurements

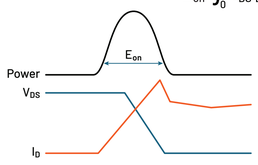


Measurements in Double Pulse Testing

Turn-on and Turn-off Energy Losses (E_{on} and E_{off})

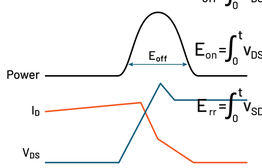
In order to calculate turn-on and turn-off parameters, we focus on the first turn-off of the switching device and the subsequent turn-on. At these points I_D should be at the target current level for the test. Turn-on energy is calculated by integrating the sampled power waveform during turn-on. Turn-off energy is calculated by integrating the sampled power waveform during turn-off.

$$E_{on} = \int_0^t v_{DS} i_D dt$$



Turn-on Parameters:
- Turn-on delay, $t_{d(on)}$
- V_{DS} fall time , t_f
- Turn-on time, t_{on}
- Max drain current, $I_{D\text{-}max}$
- dv/dt
- di/dt
- Turn-on energy, E_{on}
- Dynamic $R_{DS(on)}$

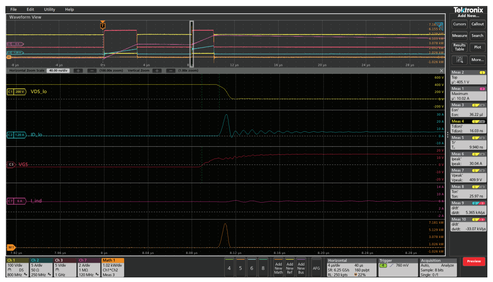
$$E_{off} = \int_0^t v_{DS} i_D dt$$

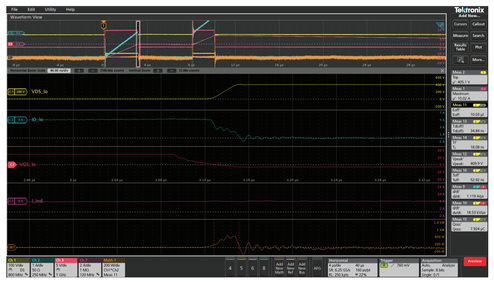


$$E_{on} = \int_0^t v_{DS} i_D dt$$

$$E_{rr} = \int_0^t v_{SD} i_{rr.max} dt$$

Turn-off Parameters:
- Turn-off delay, $t_{d(off)}$
- V_{DS} rise time, t_r
- Turn-off time, t_{off}
- Max drain to source voltage, $V_{DS\text{-}max}$
- dv/dt
- di/dt
- Turn-off energy, E_{off}
- Output charge, Q_{oss}

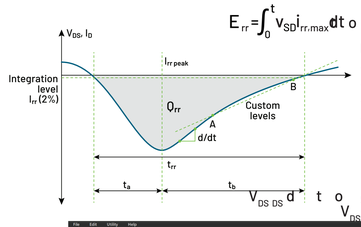




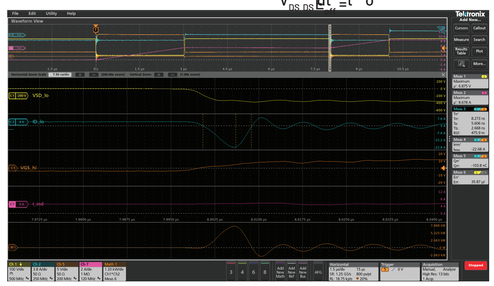
Reverse Recovery Measurements

Reverse recovery current flows through a diode for a short duration, whenever the diode switches from forward biased (on) to reverse biased (off).

$$E = E_{on} = \int_0^t v_{DS} i_D dt \quad E_{rr} = \int_0^t v_{SD} i_{rr.max} dt \quad E_{off} = \int_0^t v_{DS} i_D dt$$



Reverse Recovery Parameters:
- Reverse recovery time, t_{rr}
- Reverse recovery current, I_{rr}
- Reverse recovery charge, Q_{rr}
- Reverse recovery energy, E_{rr}
- di/dt
- Forward ON state voltage, V_{SD}



Important Standards for Double Pulse Testing

Standard	Device Type	What It Covers
JEDEC JEP182	GaN MOSFETs	Switching parameters and reliability
IEC 60747-8	SiC MOSFETs	Switching time measurements
IEC 60747-9	IGBTs	Performance specs including turn-on/off behavior

These standards provide test definitions, measurement methods, and threshold conditions essential for validating power device performance.

Avoid Common Double Pulse Test Pitfalls

- **Prioritize Safety**
  Handle high-voltage/high-speed setups carefully; use proper isolation and PPE.
- **Ensure Accurate Floating Voltage and Current Measurements**
  Measure floating voltages like V_{GS} and floating currents like I_D accurately and avoids common-mode voltage issues, especially for high-side measurements.
- **Ensure Proper Grounding**
  Establish a clean return path to minimize ground bounce and reduce ringing in captured signals.
- **Shorten Cable Lengths**
  Reduces inductance and artifacts in fast switching events.
- **Deskew Probes**
  Remove skew between voltage and current probes for accurate energy measurements.
- **Follow Test Standards**
  Verify gating and timing parameters per IEC/JEDEC specs for consistency.

Double Pulse Testing with Double the Confidence. Visit tek.com for more insights or to request a quote or demo.