ETI Double Pulse test bench for measurement and qualification of power semiconductors

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Double Pulse Test Operating Principle

- Single phase module setup, testing the IGBT T2
- Characteristic waveforms of the double pulse test
- Control (Gate) Signal green
- Measuring turn ON and OFF behavior at the second pulse
- Measuring at the same time two different operating points

Loss Calculation and Definition

- Calculation of switching energies
  \[ E_{ON} = \int_{t_1}^{t_2} v_{CE}(t) \cdot i_C(t) dt \]
  \[ E_{OFF} = \int_{t_3}^{t_4} v_{CE}(t) \cdot i_C(t) dt \]
  \[ E_{rr} = \int_{t_5}^{t_6} i_{rr}(t) \cdot v_D(t) dt \]
  \[ i_{rr}(t) = i_C(t) - i_{C,nominal} \]

- Used integration limits
  \[ t_1: v_{GE}(t) = 0.1 \cdot V_{GE,static} \]
  \[ t_2: V_{CE}(t) = 0.02 \cdot V_{DC-link} \]
  \[ t_3: v_{GE}(t) = 0.9 \cdot V_{GE,static} \]
  \[ t_4: i_C(t) = 0.02 \cdot i_{C,nominal} \]
  \[ t_5: i_C(t) = i_{C,nominal} \]
  \[ t_6: V_D(t) = 0.02 \cdot V_{DC} \]

- Typical switching characteristics of an IGBT

Novel Developed Fully Automated Test Bench

- Fully automated test bench (LabVIEW and ETI DSP-System based)
- Max. DC-Link voltage: \( V_{max} = 1.8 \) kV
- Maximal current pulse: \( I_{max} = 4 \) kA
- Maximal measurable current slope: \( \frac{di}{dt} = 6 \) kA/μs
- Adjustable junction temperature: \(-20^\circ C < T_J < +160^\circ C\)
- Measurement of conduction characteristics
- Measurement of switching behavior
- Evaluation of the measured data with Matlab and LabVIEW

- Fully automated switchable choke
  - Configurable choke with seven different effective inductances
  - Selection of desired inductivity via thyristors
  - ensuring safe operation