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Analysing a gate-boosting circuit for fast switching

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A challenge in fast switching of voltage-controlled power semiconductor devices such as MOSFETs and IGBTs is fast charging of the gate capacitance. As gate drive circuit and device leads both involve stray inductance, the rise rate of the gate current is limited. To achieve higher current rise rates, an overvoltage might be applied to the gate leads (so called gate-boosting) [1]. In this work, a simple gate-boosting circuit has been investigated. It allows using a gate drive voltage in the order of 100V whereas the voltage across the internal gate capacitance is kept well below the limit for the gate-emitter voltage as given in the datasheet. Hence, damage to the gate oxide layer is prevented. For the design process, it is of advantage to verify the voltage across the internal gate capacitance in the TO-247 package by measurements in addition to simulation results. For such measurements, the protective plastic housing around the die has been partly removed by means of an etching process. With a probe specifically modified for low inductance, measurements of the voltage across the gate capacitance in direct vicinity to the die have been performed. This work presents steps towards achieving a fast rising voltage across the gate capacitance within permissible limits, whereas the voltage across the device leads outside of the housing exhibits high inductive peaks. As result, improvements of the load current's rise rate in hard switching conditions by a factor of around 8 up to 4.2kA/µs at a rise time of 50ns for a commercially available TO-247 IGBT have been demonstrated.

[1] Nguyen, M. N.; Cassel, R. L.; deLamare, J. E.; Pappas, G. C. (2001): Gate drive for high speed, high power IGBTs.
In PPPS-2001: PULSED POWER PLASMA SCIENCE 2001, VOLS I AND II, DIGEST OF TECHNICAL PAPERS.

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