Performance evaluation of diodes in 27.12 MHz Class-D resonant rectifiers under high voltage and high slew rate

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Abstract

This paper provides a performance review of select diodes for use in high frequency resonant rectifiers at modest power levels. Specifically, we evaluate the performance of several leading edge diodes for use in a 27.12 MHz Class-D type rectifier for output voltages from 170 V to 1000 V dc, and corresponding power levels between 8.5 W and 100 W. Previous work on resonant rectifiers at frequencies > 10 MHz [1] showed higher than expected losses in the diodes. These losses increased with increased output voltage and led to significant de-rating and poor utilization of the semiconductors. The authors suspect these losses are due in part to the high dv/dt experienced by the Silicon Carbide (SiC) Schottky diodes used in that design. This paper provides an in depth comparison of select diodes to evaluate their performance for use at elevated voltages and frequencies. Further understanding of the losses involved in the design of high dv/dt resonant rectifiers will lead to better de-rating guidelines for component selection of high frequency high voltage converters.

Characterizing Diode Losses Under High Voltage Slew Rate

- Initial design was 35% efficient
- Losses were not accounted for by models or information provided by manufacturers
- Losses in the diode were principal suspect as source of discrepancy

Estimated Diode loss at various output voltages, IOUT=100mA (600V SiC Diodes)

- Notice that the diode loss is similar at both current levels but increases significantly with output voltage.

Direct Comparison of Similarly Rated Parts

- VOUT = 500 V, IOUT = 100 mA fS = 27.12 MHz
- D1, Infineon
- D2, ST Microelectronics

Conclusions and Next Steps

- Significant difference in high frequency performance between SiC devices of different manufacturers
- Apparent dv/dt related loss mechanism not characterized by manufacturers
- 600 V devices from two manufacturers outperformed their own 1200 V devices
- The Silicon Schottky provided the highest efficiency and best match with simulation
- Extend the study to GaN devices