A Step-by-step Modelling Approach for SiC MOSFETs Halfbridge Modules Considering Temperature Characteristics

ESR1 - Peng Yang Supervisors: Jun Liang and Wenlong Ming Cardiff University, United Kingdom











- □ Very few commercial models for SiC MOSFET power modules.
- □ Most power electronics designers are not expert in semiconductors.
- □ A modelling method based on datasheet is preferred for most designers.
- A step-by-step modelling approach to help the designers to extract the model parameters is required.

Structure overview





- Discrete device: single switch package
- Power module: multi-chip multi-switch package





Source: https://sunypoly.edu/research/centers-programs/sunycasper/capability/packaging-design-and-outsourcing.html

Source: https://www.eenewseurope.com/news/sic-power-modules-halve-power-losses-inverters

Equivalent circuit





Reference: Baliga, B. Jayant. Fundamentals of power semiconductor devices. Springer Science & Business Media, 2010.

Equivalent circuit with anti-parallel diode

- In power modules, SiC MOSFETs are usually anti-paralleled with SiC Schottky ۲ Diode
- SiC Schottky Diode has the advantage of low voltage drop and no reverse ٠ recovery current.
- The body diode of SiC MOSFETs can be ignored due to the lower voltage drop ٠ of SiC Schottky Diode.







Overview of modelling process





Model description





Modelling approach of I_{DS}





Modelling approach of Diode and Capacitance





Verification: I-V characteristics

-50

Tj (°C)

-50

Tj (°C)





-50

Tj (°C)

-50

Tj (°C)

Verification: Diode & C-V characteristics







Verification: Transient simulation & Experiment















- A step-by-step modelling approach of SiC MOSFETs considering temperature dependency is proposed.
- □ The parameter extraction procedure of I_{DS} model, Diode model and Capacitance model is detailed illustrated via flowchart.
- □ The model is validated by comparing the simulation results with experiment results.
- □ This modelling approach is based on datasheet without additional measurement requirement.
- This modelling approach is helpful for power electronics designers to design their own models for various SiC MOSFETs power modules.



Thanks for listening !

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement no. 765585

This presentation reflects only the author's view. The Research Executive Agency and European Commission are not responsible for any use that may be made of the information it contains.