In-Packe Package Common-Mode Filter for GaN Power Module with Improved Radiated EMI Performance

Niu Jia¹, Xingyue Tian¹, Hua Bai¹, Leon Tolbert¹, Helen Cui¹
¹ The University of Tennessee, Knoxville

OBJECTIVES
Integrate a common mode filter (CMF) inside a half-bridge GaN-based power module package with:

- High integration with in-package decoupling capacitors, integrated gate drivers and common mode filter for the module.
- High EMI attenuation targeting 30 MHz to 100 MHz radiated frequency range.
- More benefit than identical external common mode filter.

CHALLENGES
- Parasitics analysis and common mode equivalent circuit building.
- High difficulty in power module integration processes.
- EMI test design.

MODEL BUILDING

Vertical view of designed power module package with CMF integrated

PARASITICS ANALYSIS

According to LISNs’ gain analysis:

- Smaller $Z_{CMF-PM}$ and $Z_{CMF-RS}$ reduce the noise received by LISNs.
- $Z_{CMF-PM}$ and $Z_{CMF-RS}$ can be minimized by in-package CMF, so more attenuation can be achieved.

TEST RESULTS

- Benefit is showed by in-package CMF.
- EMI test results are affected by parasitics resonance.

CONCLUSION

- Integrating CMF inside the package is proposed as a WBG device power module package design concept.
- Different parasitics distributions caused by different CMF placements in the system can affect the CMF’s performance.
- Minimizing the parasitic inductances of the CMF to the power module and to the heatsink, the CMF can achieve a larger EMI attenuation.
- The benefit of in-package CMF is verified both theoretically and experimentally.