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

Niu Jia[1], Xingyue Tian[1], Hua Bai[1], Leon Tolbert[1], Helen Cui[1]
[1] The University of Tennessee, Knoxville

OBJECTIVES

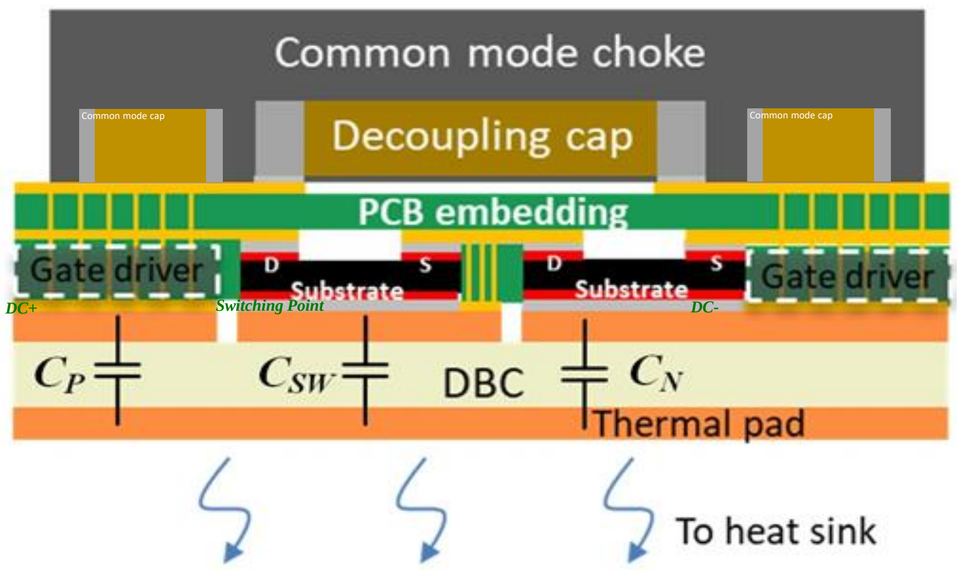
Integrate a common mode filter (CMF) inside a half-bridge GaN-based power module package with:

- 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

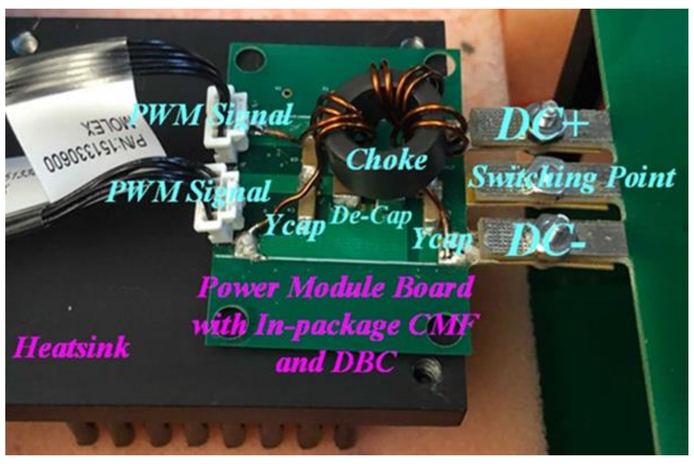
- Parasitics analysis and common mode equivalent circuit building.
- High difficulty in power module integration processes.
- EMI test design.

MODEL BUILDING

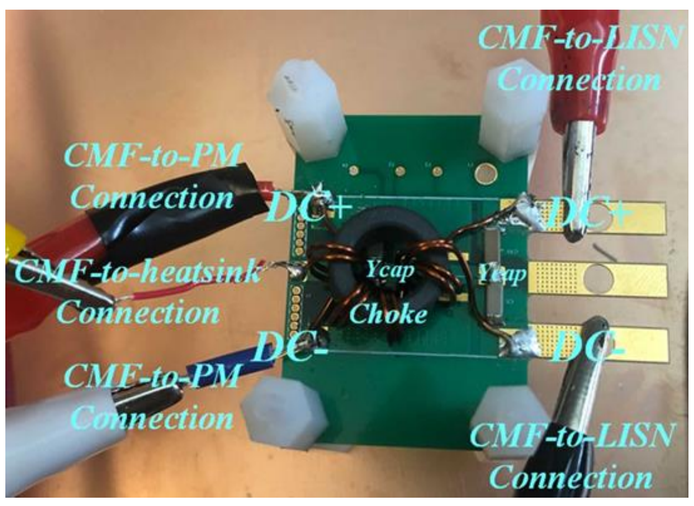


Vertical view of designed power module package with CMF integrated

PROTOTYPES

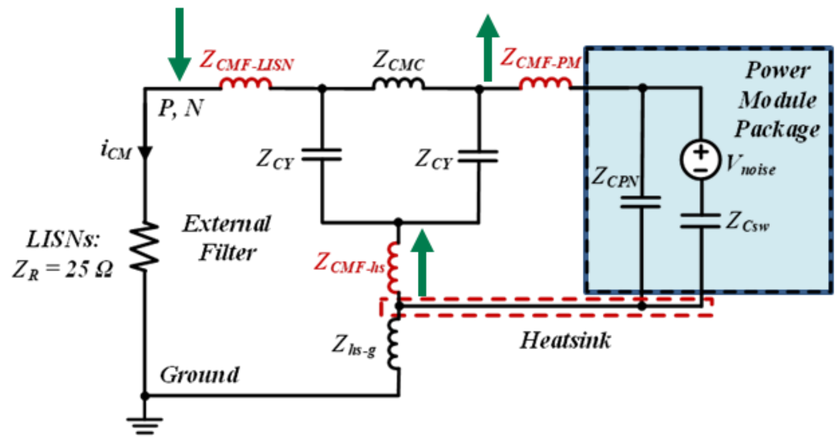


In-package CMF

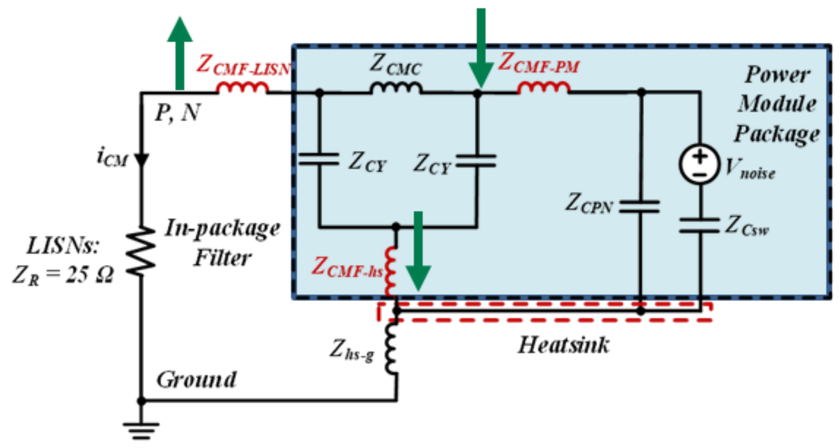


External CMF

PARASITICS ANALYSIS



CM equivalent circuit with external CMF

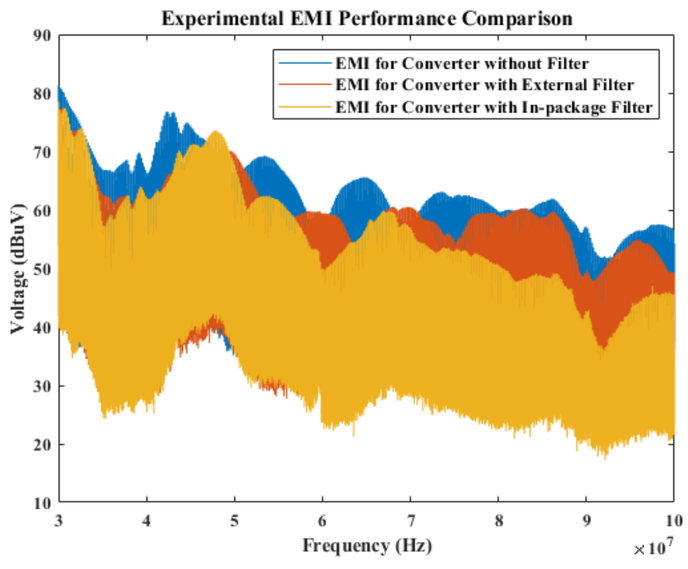


CM equivalent circuit with in-package CMF

According to LISNs' gain analysis:

- Smaller Z_{CMF-PM} and Z_{CMF-hs} reduce the noise received by LISNs.
- Z_{CMF-PM} and Z_{CMF-hs} 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.