Double-side Cooled 1.2kV, 300A SiC MOSFET Phase-leg Modules for 200 kW, > 100 kW/L Traction Inverters

The rise of electrified vehicles (EVs) reflects the growing demand for cleaner and more efficient transportation. This trend includes various electrified powertrains like hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell vehicles. To drive these machines, a crucial component is the traction inverter, converting the battery pack's direct current into variable frequency alternating current.

The Department of Energy (DOE)'s Vehicle Technology Office (VTO) aims for a significant increase in power density, targeting 100 kW/L by 2025, up from 18 kW/L in 2020. To achieve this aggressive target, replacing current Si power devices with SiC wide bandgap devices is necessary. SiC devices offer a smaller footprint with equivalent ratings, reducing costs and enabling compact power module designs. Double-side cooled modules sandwiching device chips between electrically and thermally conductive substrates with metal inter-posts had been successfully demonstrated, resulting in enhanced thermal performance, a smaller footprint, and reduced package parasitic inductances.

In recent years, we reported the packaging of a double-side cooled phase-leg module for meeting the DOE VTO's target of 100 kW, 100 kW/L traction inverters. Each phase-leg module consists of two 1.2 kV, 149 A SiC MOSFETs: one per switch position. Six of the phase-leg modules have been assembled into a segmented inverter configuration by researchers at the Oak Ridge National Laboratory to meet the power and power density requirement.

This study is aimed at redesigning the module layout to include four of the devices for making 200 kW, > 100 kW/L traction inverters.

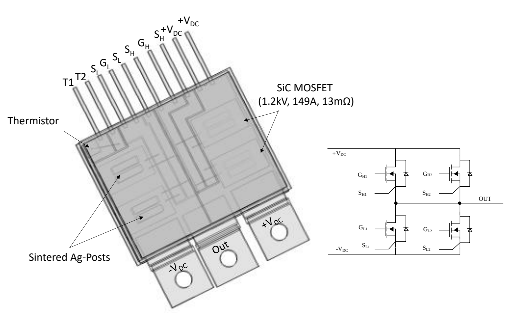

Fig. 1. Layout design of the four-chip SiC MOSFET phase-leg module with double-sided cooling

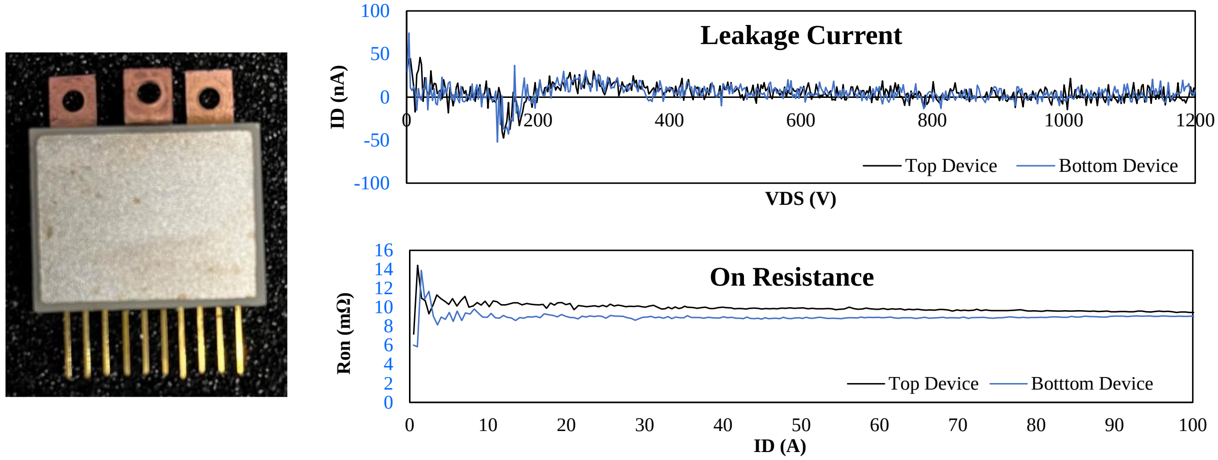

Fig. 2. A) Fabricated 1.2kV 300A SiC MOSFET power module b) Plots of on-resistance and leakage current