A Passive Balancing Method for Dynamic Current Sharing of Paralleled SiC MOSFETs with Kelvin Source Connection

Paralleling the SiC MOSFETs is a popular and cost-effective solution to increase current capacity. However, the unbalanced dynamic that current sharing among the paralleled SiC MOSFETs can yield issues of unbalanced losses, unequal junction temperatures, or even thermal runaway, which may lead to the device failure. For industrial applications, a low-cost solution is needed to balance the dynamic currents.

The mechanism of dynamic current sharing is first analyzed. Fig 1(a) shows the circuit diagram of paralleled SiC MOSFETs in low side switching position when operating in the dynamic region. It is found that the mismatched source parasitic inductance L_S creates unbalanced gate-driving currents in the dynamic region. Since the SiC MOSFETs are working in the saturation region, the unbalanced gate-driving currents result in different charging speed and eventually cause unbalanced dynamic channel currents.

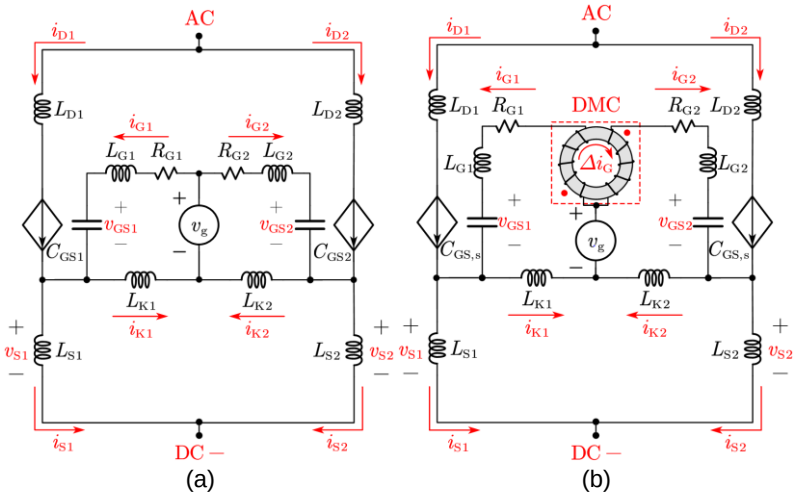

Fig.1. The circuit diagram of paralleled SiC MOSFETs (a) without proposed method and (b) adopting the proposed balancing method.

Fig 1(b) shows a circuit diagram of the proposed current balancing method. A differential mode choke (DMC) is inserted into the gate-driving paths. The DMC is magnetized when the gate currents are unbalanced. The magnetizing inductance helps suppress the unbalanced gate currents. Once the gate currents are balanced, the dynamic channel currents can also be balanced.

Fig. 2 shows the experimental results by adopting the proposed method. Apparently, the proposed method helps balance the dynamic currents. The degree of unbalanced currents decreased by 84%.

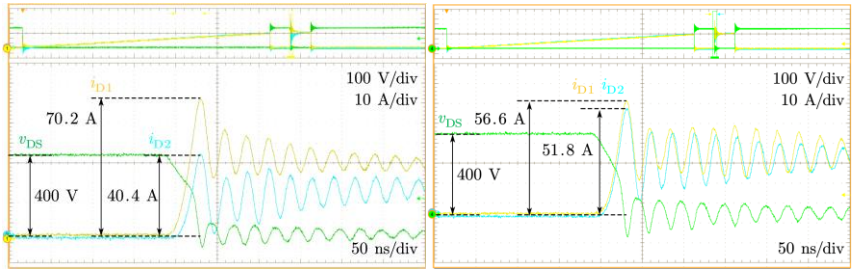

Fig. 2. Experimental results (a) without proposed method and (b) adopting the proposed balancing method.

This paper proposes a low-cost, current-balancing solution. The mechanism of dynamic current sharing is studied. It is found that the mismatched layout effects the gate-charging currents and leads to unbalanced dynamic currents. Based on the mechanism, a current-balancing method by

using DMC is proposed. The experimental results clearly verify the effectiveness of the proposed method. More detailed results will be provided in the final paper.