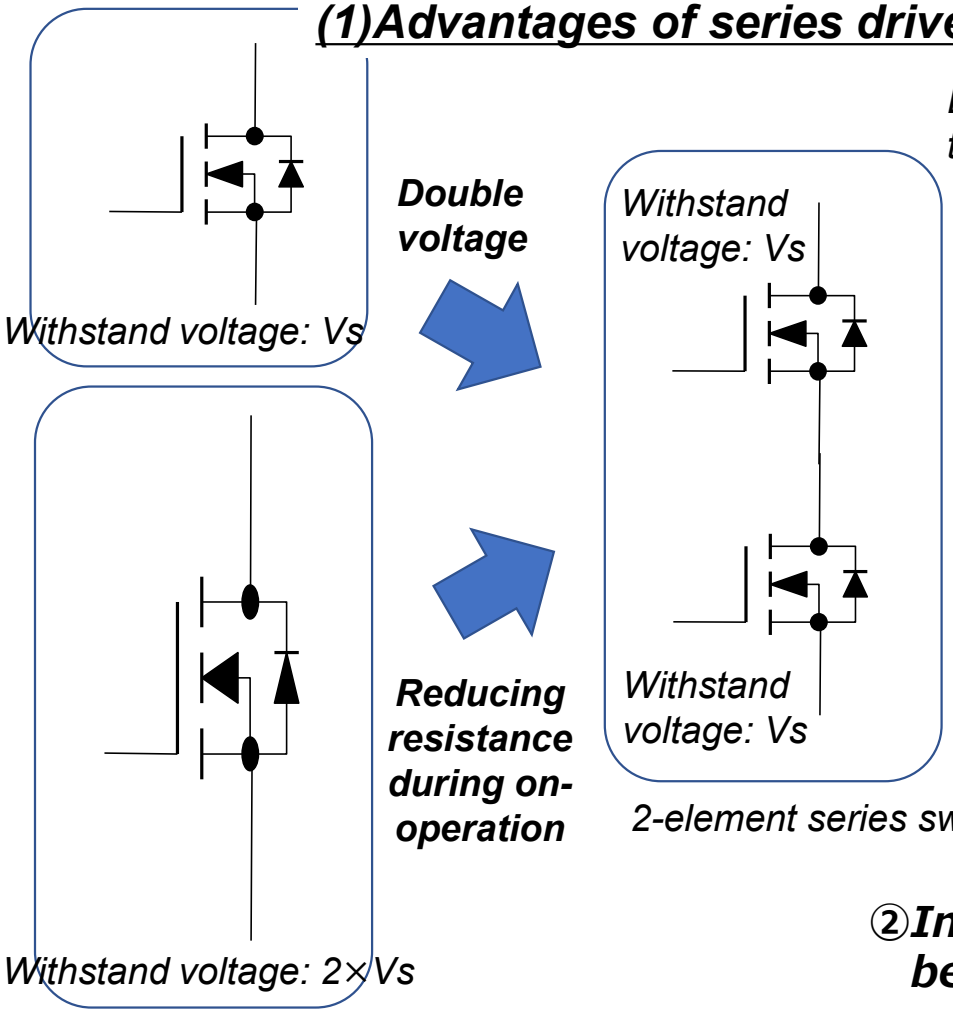
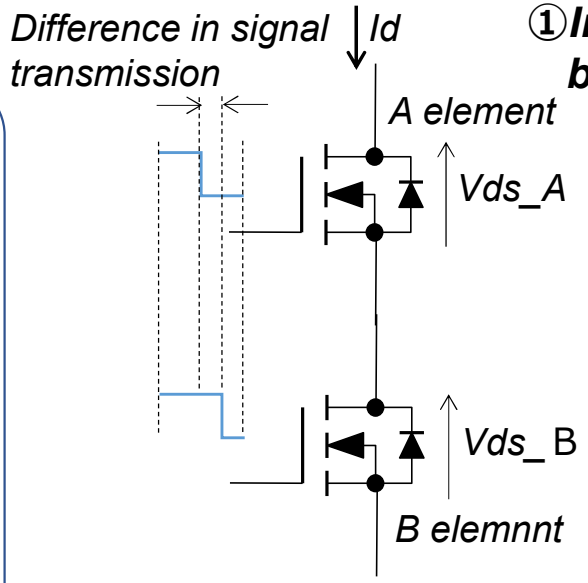
Purpose: Realizing of power semiconductor module series drive technology for low loss and low cost of power electronics equipment

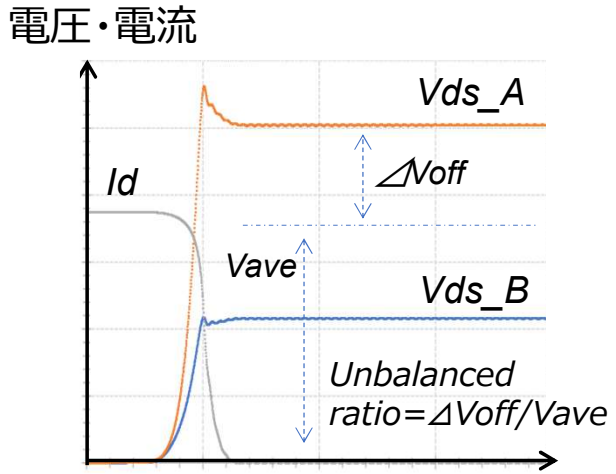
(1)Advantages of series drive



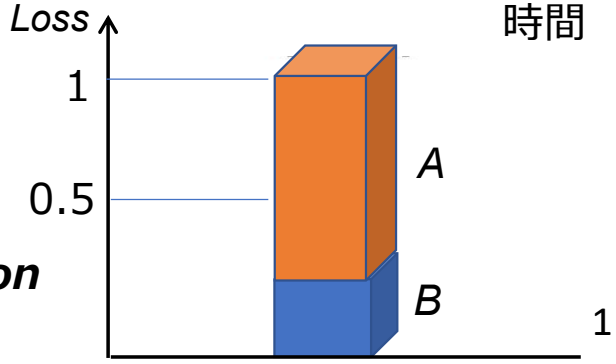
(2)Challenges of series drive

①Imbalance of applied voltage between elements





②Imbalance of heat generation between elements

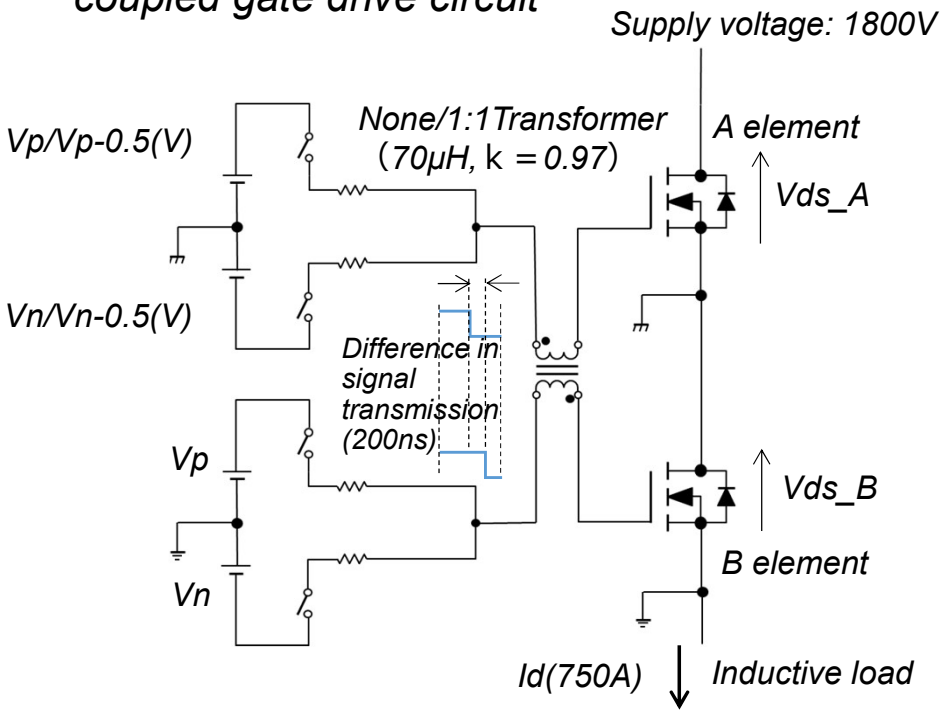


1. When the magnetic coupling method [1] is used to drive SiC power semiconductors in series, the effects of gate signal and gate voltage deviation are verified using a circuit simulator.

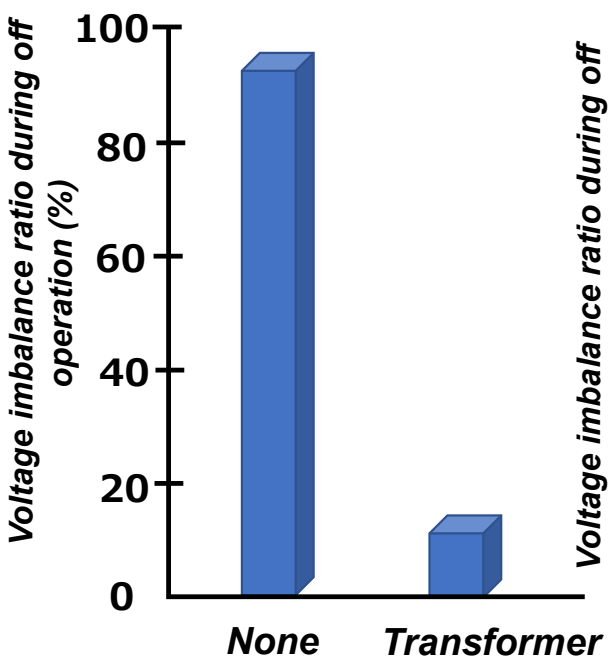
(1)Verification conditions

①Target device
3.3kV/750A, SiC-MOSFET/SBD power module

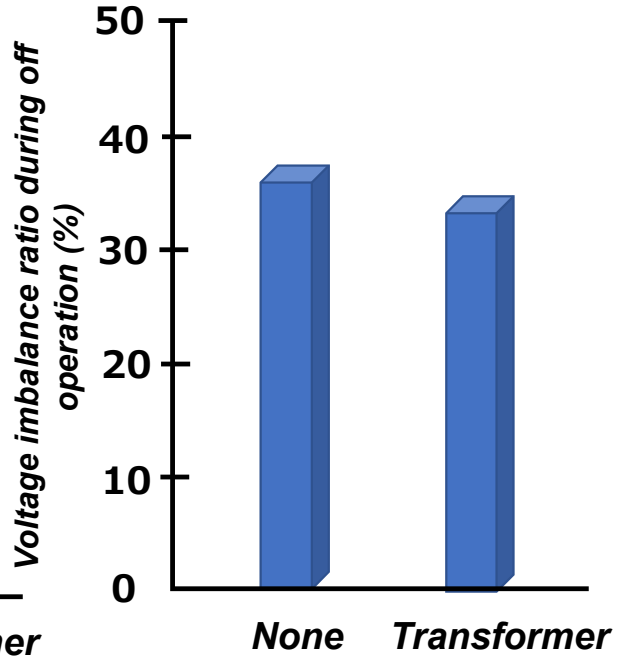
②Configuration and conditions of magnetically coupled gate drive circuit



(2)Simulation result



(a)There is a difference in 200ns gate signal transmission
(No difference in gate voltage)



(b)There is a 0.5V difference in gate voltage (same amplitude potential difference)
(No difference in gate signal)

The magnetic coupling method has a large effect on signal differences and a small effect on gate voltage differences.

(1)Kiyoaki Sasagawa, Yasushi Abe, and Kouki Matsuse, "Voltage-Balancing Method for IGBTs Connected in Series", IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS, VOL. 40, NO. 4, JULY/AUGUST 2004, 1025-1032 (2004)

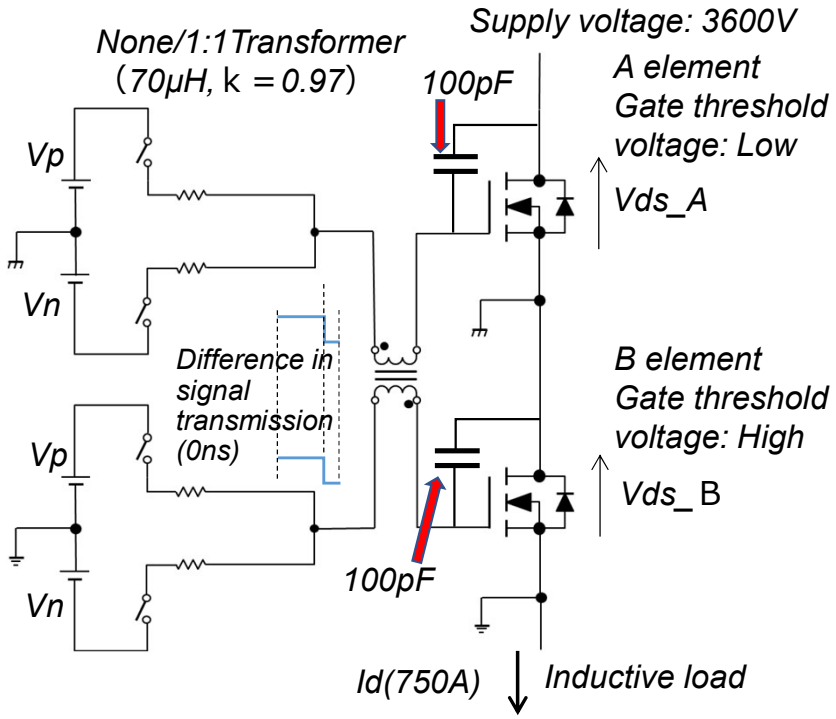
2. Combination of magnetic coupling method and capacitors improves voltage imbalance caused by gate threshold voltage difference. (Circuit simulation verification)

(1)Verification conditions

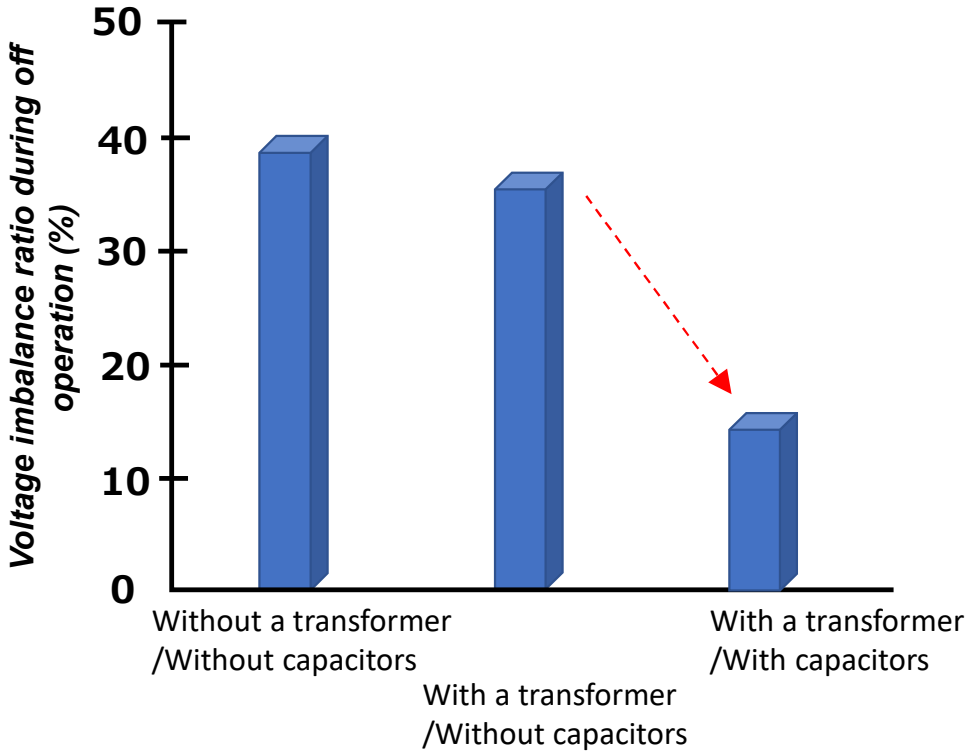
①Target device

3.3kV/750A, SiC-MOSFET/SBD power module

②Configuration and conditions of magnetically coupled gate drive circuit



(2)Simulation result



Conditions for difference in threshold voltage

(No difference in gate signal)