

The Art of Driving Power Semiconductor Devices

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Power MOSFETs, Insulated Gate Bipolar Transistors (IGBTs), Wide bandgap (WBG) power devices such as Gallium Nitride (GaN) and Silicon Carbide (SiC) power transistors are the workhorse of modern power electronics. Their voltage ratings, switching characteristics and cost performance ratio have allowed them to gain a strong foothold in wide range of applications, from consumer electronics, telecommunications, to industrial and electric vehicle applications. Although the aforementioned power semiconductor devices have MOS-like gate electrodes, turning them on or off requires much more than just applying a high or low voltage. Recent trends for smart gate driver ICs are to integrate a variety of complex functions to provide better protection, monitoring, and local control of the switching behaviors of the power devices. This presentation starts with the reviews of basic gate driving requirements. This is followed by the introduction of recent developments in smart integrated gate drivers that are specific to the stringent requirements for GaN and SiC power transistors. Smart gate driver ICs with innovative integrated features such as dynamic gate driving and dead-time correction to minimize EMI and switching losses will be discussed. Techniques to provide picosecond time resolutions to automate the determination of the dynamic gate drive profiles dedicated by these much faster WBG power devices will be described. Finally, new gate drive features such as health monitoring, aging detection and compensation for the SiC devices will also be presented.