

## Selection and Utilization of Power MOSFETs for Optimal Energy Efficiency in High Frequency Switching Systems

Sanjay Havanur

Sr Manager System Applications, Vishay Siliconix, Santa Clara, CA 95054-1866, USA

Accepted for publication on 3rd April 2015

Efficiency standards for power supplies have been getting stringent over the years, with 90% and above being the norm today. Power MOSFETs are devices of choice in high frequency converters due to their ability to switch extremely fast, at the same time keeping the conduction losses low. This paper presents an overview of current power semiconductor technology with focus on power MOSFETs and comparable devices. We cover different silicon technologies like planar, trench, superjunction, as well as GaN and SiC, with emphasis on parameter comparisons that influence their switching performance.

Conventional approach to MOSFET selection relies on the so called Figure of Merit (FOM) defined as the product of  $R_{dson}$  and  $Q_g$ . Several variants have been proposed, replacing  $Q_g$  with switching charge  $Q_{sw}$ , output charge  $Q_{oss}$ , or combinations of other parameters. Generally any reduction in  $R_{dson}$ , which relates to conduction losses, leads to an increase in  $Q_g$  which relates to switching losses. It is assumed that a device with the lower product of the two will therefore have lowest overall losses. System studies have shown that such simplistic definitions do not take into account all the loss mechanisms or their relative contributions to the total loss. The conventional FOM considers only the bulk property of a design platform and is blind to the operating environment. Modern power converters operate over a wide range of conditions, with two orders of magnitude variations in voltage, current and frequency. It is impossible for a single generic number to guide the system designers towards the most efficient solution in each and every application.

An application specific Figure of Merit is proposed here as the weighted sum of different MOSFET parameters. The weighting coefficients are calculated from operating conditions, ensuring that all relevant data is built into the equation. The proposed FOM is a measure of the total loss specific to the application and helps system designers select the right MOSFETs for the most energy efficient solution. Methodology of deriving the new FOM is explained. Experimental studies on different converters are presented to show the limitations of the conventional FOM as well as the validity of the proposed solution.

Keywords: MOSFETs; Power Conversion; Figure of Merit; Efficiency



## Selection and Utilization of Power MOSFETs for Optimal Energy Efficiency in High Frequency Switching Systems

Sanjay Havanur

Sr Manager System Applications, Vishay Siliconix, Santa Clara, CA 95054-1866, USA