

Single-Inductor Dual-Output DC-DC Buck Converter Design With ZVS-PWM Control

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Nowadays, various voltages are required in order to operate electrical appliances, where usually DC-DC converters of the same number as the voltages are required, and one inductor is required for one converter. Such a configuration is expensive and occupies considerable board area because the inductor size is relatively large. Therefore, there is an increasing interest in single-inductor-multiple-output (SIMO) DC-DC converters. We have investigated DC-DC converters with SIMO configuration^{1,2}. For example, our recent study reported hysteresis control for SIMO DC-DC converters³.

In this paper, we study a pulse-width-modulation (PWM) control of zero-voltage-switching (ZVS) for single-inductor dual-output (SIDO) buck converters. This method can meet the industry demands for high efficiency due to ZVS and small size and low cost, thanks to single-inductor per multiple voltages. We apply the proposed control to SIDO DC-DC buck converter and verify its performance with simulation. Our simulations have confirmed a stable operation using the proposed control, and we present their results.

Fig.1 shows a SIDO buck converter with the ZVS-PWM control method. There SEL signal is generated to determine whether the inductor current is supplied to Vo1 or Vo2 by comparing $\Delta Vo1 (= Vo1 - Vref)$ and $\Delta Vo2 (= Vo2 - Vref)$; Vo1 is selected when $\Delta Vo1 > \Delta Vo2$. We call this as “exclusive control.” It is at the timing when ZVS signal is detected and M1 is turned ON. Fig. 2 shows the transient response when the load currents are changed. We see that both the self- and cross-regulation voltages are in the order of several 15mV which is less than 0.3% of Vo1, Vo2. This result is satisfactory in many applications.

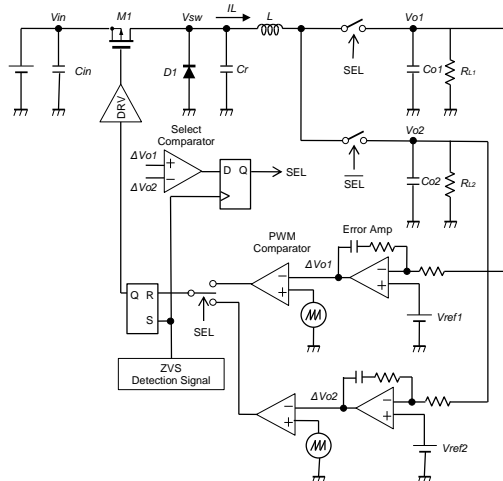


Fig. 1 Proposed SIDO buck converter circuit with ZVS-PWM control.

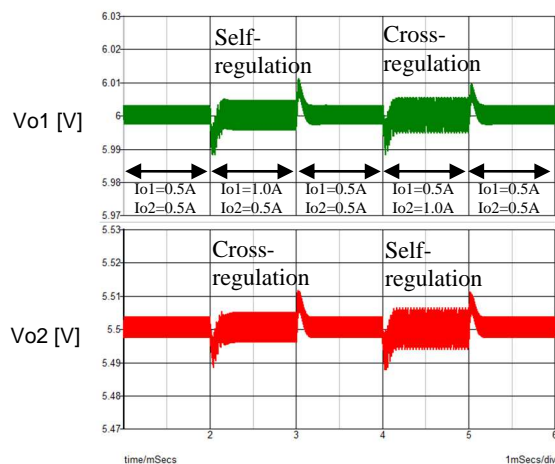


Fig. 2 Transient response simulation results of the proposed SIDO buck converter with ZVS-PWM control.

¹N. Takai et al., “Low Power Consumption Control Circuit for SIBO DC-DC Converter,” International Conference on Analog VLSI Circuits, Valencia, Spain, October 2012.

²Y. Kobori et al., “High-Speed Response Single Inductor Multi Output DC-DC Converter with Hysteretic Control,” 1st Annual International Conference on Power, Energy and Electrical Engineering, Singapore, August 2013.

³S. Tanaka et al., “Single Inductor Multi Output DC-DC Converter Design with Hysteresis Control,” The 4th IEICE International Conference on Integrated Circuits Design and Verification, Ho Chi Minh City, Vietnam (Nov. 15-16, 2013).