Advanced Abnormal Over−current Protection with SuperFET® 800V MOSFET in Flyback converter

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ABSTRACT

This paper presents an advanced abnormal over−current protection with SuperFET® 800V MOSFET in Flyback converter. In advanced abnormal over−current protection, digital pattern generator is proposed to detect a steep di/dt current condition when secondary rectifier diode or the transformer is shorted. If current sensing signal is larger than current limit during consecutive switching cycle, Gate signal will be stopped for 7 internal switching periods. If the abnormal over−current maintains pattern, the controller goes into protection mode. The Advanced over−current protection has been implemented in a 0.35um BCDMOS process (ON Semiconductor process).

1. INTRODUCTION

Flyback converter is widely used in many power electronic applications [1]. The Flyback converter consists of several function blocks such as input power stage, transformer, controller, output stage, and shunt regulator with KA431 as shown in Figure 1. In this system, when the secondary rectifier diode or the transformer is shorted, a steep di/dt current can flow through the power sense SuperFET® during the short time duration [2]. Therefore, power MOSFET is seriously stressed.

To overcome this problem, this paper proposes an advanced abnormal over current protection (=AOCP) function with digital pattern generator.

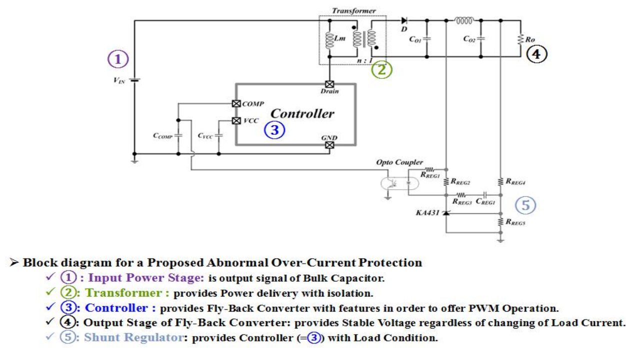

Figure1 Two Chip – One Package Controller with Flyback converter.

This paper is organized as follows. Section 2 present the operation principle of the proposed AOCP technique, while different design considerations including the pattern analysis. Finally, Section 3 provides the experimental results of the proposed AOCP function in Flyback converter. In Section 4 draws conclusions.

2. DESIGN OF THE PROPOSED AOCP FUNCTION

The conventional method uses fixed voltage reference as an input of AOCP comparator to detect AOCP event. Sometime, according to difference between current limit and AOCP threshold voltage, it is impossible to detect AOCP event accurately. Additionally, if we employ line compensation function, there is dead zone originated from the gap between current limit value and fixed reference values. On the other hand, the proposed method uses adaptive voltage reference with time window and digital pattern generator to detect AOCP event regardless of line voltage condition as shown in Figure 2. This figure shows block diagram of the abnormal over current protection. The current limit profile has fixed value or variable value. The current limit profile makes threshold voltage for AOCP comparator. The output of AOCP comparator provides pattern generator. Finally, the pattern generator makes AOCP protection signal. By using this configuration, we can reach AOCP function operation.

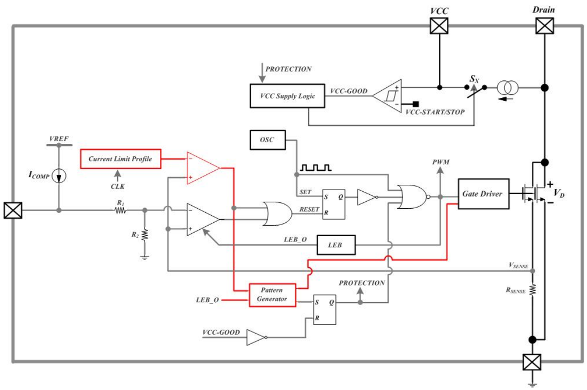

Figure 2. Block Diagram for Advanced Abnormal Over-Current Protection

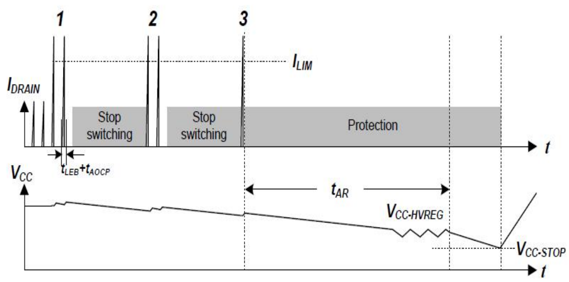

Figure 3 Timing Chart for Advanced Abnormal Over-current Protection

Figure 3 shows Timing chart for advanced abnormal over-current protection. The controller monitors current-sense signal within a time duration $t_{LEB}+t_{AOCP}$, which is leading-edge blanking time plus an extra duration for AOCP function. When current-sensing signal exceeds current limit for two consecutive times, GATE signal will be stopped for seven switching periods, which is decided by internal oscillator. The GATE signal resumes after counting seven switching periods as shown in Figure 3. If the condition is unchanged right after the GATE signal is resumed, 2 (two consecutive pulse) + 7 (Gate off signal) pattern repeats again. And if AOCP condition is kept, the controller will go into protection condition.

3. EXPERIMENTAL RESULTS

In order to verify the proposed advanced AOCP function technique, the block diagram shown in Figure 2 was fabricated in a 0.35um BCDMOS Process. Figure 4 shows measurement results for the proposed advanced AOCP function when transformer is shorted. The input voltage range of the Flyback converter is varied from 85V to 265V for universal input condition. Based on measured results shown in Figure 4, the proposed advanced AOCP function allow the controller to achieve protection of SuperFET® 800V MOSFET regardless of low line condition and high line condition.

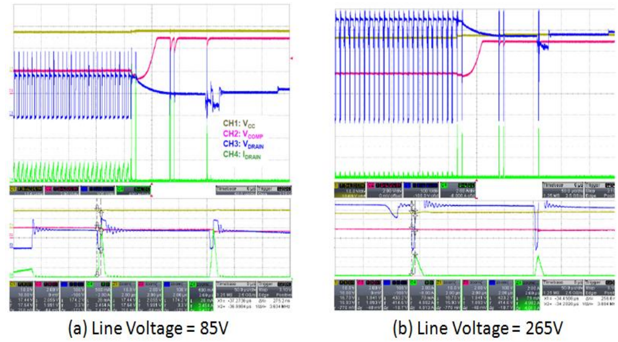

Figure 4 Measurement Results for Advanced Abnormal Over-Current Protection with low line voltage and high line voltage.

4. CONCLUSION

In this paper, an advanced abnormal over-current protection with digital pattern generator has been presented. Digital pattern generator enables the realization of preventing an abnormal over-current that can flow through the SuperFET® 800V MOSFET effectively. The advanced abnormal over-current protection function (AOCP) is stable for low line condition and high line condition. This work is verified on silicon and comparisons with the previous product are presented.

REFERENCE

[1] Abraham I. Pressman, Switching Power Supply Design, McGRAW-HILL INTERNATIONAL, pp.105-1306, 1999.

[2] ON Semiconductor, Design Guides for off-line Flyback converters, 2003