eFuse Protection Mechanism Against Biomedical Device Failure

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Abstract

Nowadays, more and more sensors and instruments are applied for biomedical use. To avoid the risk caused by excessive current during operation, overcurrent protection is usually adopted.

The goal of this research is to study high-precision eFuse IC. When overcurrent occurs on account of heavy load or short circuit, eFuse IC can limit the current rapidly and realize overcurrent protection.

Introduction

In comparison with conventional fuses, eFuse IC has high-precision protection function, e.g., short circuit protection, overcurrent protection, overvoltage protection, etc, which is shown in Fig.1.

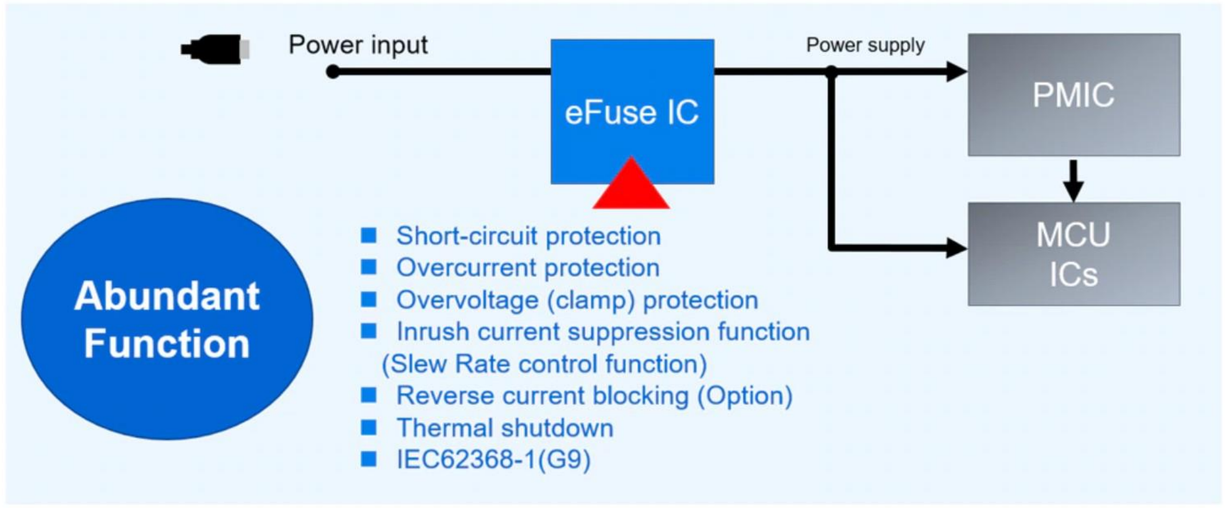

Fig. 1. Functions of eFuse IC.

Conventional chip fuses and glass tube fuses are built to stop the overcurrent occurrence that melts down metals inside. Therefore, it breaks at one time and need to be connected again for next use.

On the other hand, the eFuse IC shown in Fig. 2 can be used repeatedly in semiconductor control because the internal overcurrent protection circuitry can detect the current with high accuracy to prevent the internal MOSFET from cutting off.

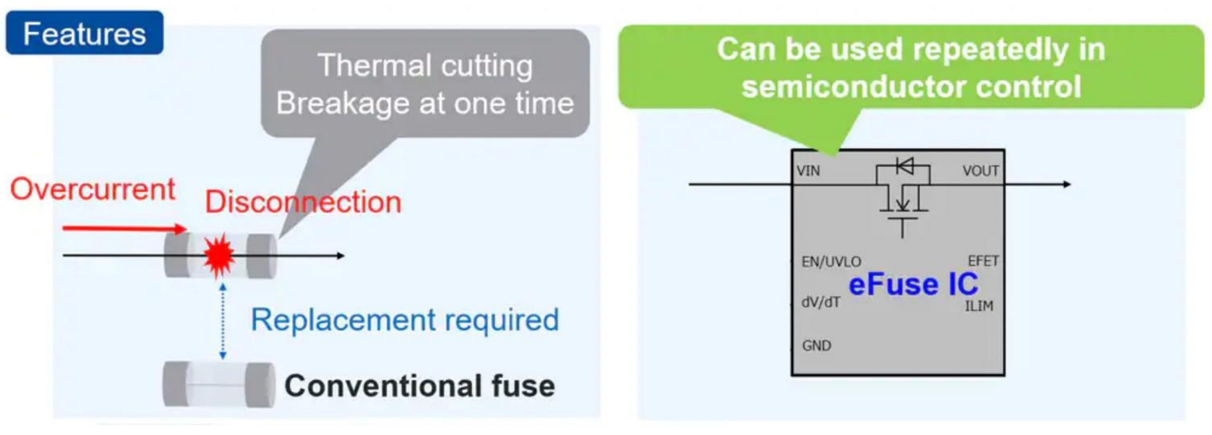

Fig. 2. Mechanism of Conventional fuse and eFuse IC

Fig. 3 shows the comparison between conventional fuses and eFuse IC. The eFuse ICs have advantages in high accuracy of overcurrent protection and short responding time, which can be applied to some biomedical instruments and equipment.

The efuse IC itself is larger than a chip fuse. However, eFuse IC mounts small area in total area including the protection functions of peripheral ICs and components.

Despite that a higher cost than a conventional fuse, considering the merits in Fig. 4 such as integrating protective functions and eliminating maintenance work, an eFuse IC still has the potential for the replacement of a conventional type.

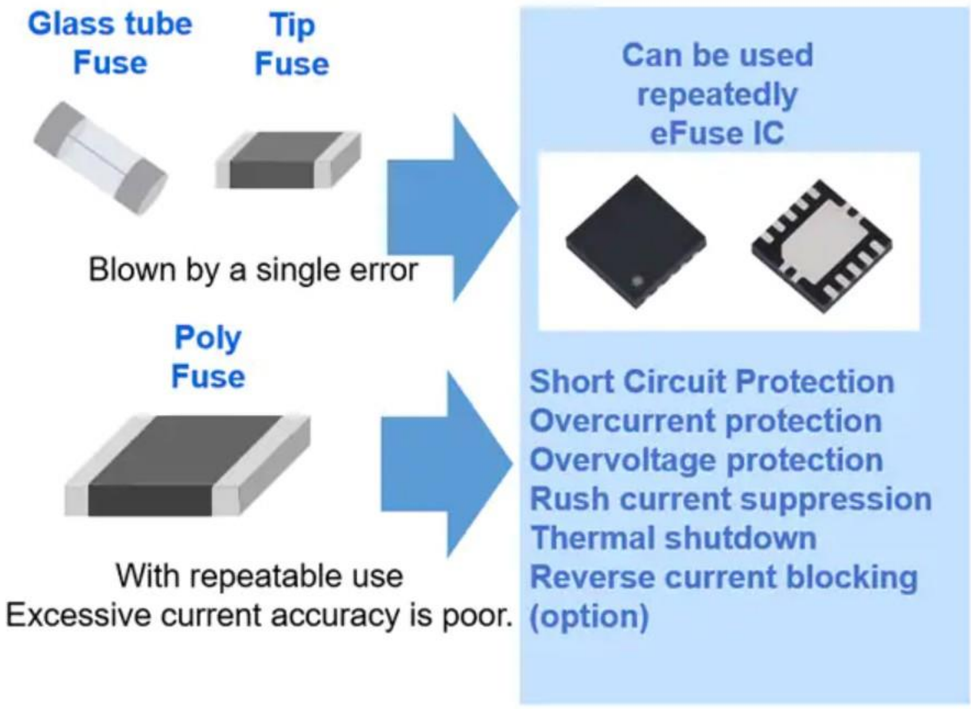

Fig. 3. eFuse IC advantages.

	Glass tube Fuse	Tip Fuse	Poly Fuse	Semiconductor fuse : eFuse IC
Repeatability	-	-	✓	✓✓✓
Overcurrent protection Speed and accuracy	-	-	-	✓✓✓
Other protection functions	-	-	-	✓✓✓
Effect of ambient temperature	-	-	-	✓✓✓
Single unit mounting area	-	✓✓	-	✓
Including protection circuit Total mounting area	-	-	-	✓✓✓
Cost of individual parts	✓	✓✓	-	✓
Function and maintenance Including total costs	-	-	-	✓✓✓

Fig. 4. Comparison between eFuse IC and conventional fuse .

In brief, an eFuse IC is a semiconductor switch. Internal circuits can be protected instantly by an eFuse circuit. An error is detected in the semiconductor circuit and the original current path is immediately closed by the MOSFET switch. In addition to reusability, an eFuse IC can achieve only 150ns short-circuit protection time, as shown in Fig. 5, which is about 10^6 times faster than a conventional fuse.

	Glass tube fuse	Chip fuse	Poly fuse (Resettable fuse)	Electronic fuse Toshiba eFuse IC
Protection method	Blown conductive part	Blown conductive part	Current limit by resistance increase	Shut down by MOSFET switch
Protection speed	Several seconds	Several seconds	Several hundred ms to several seconds	150ns (Typ.)
Repeated use	No	No	Yes	Yes

Fig. 5. Performance comparison between an eFuse and conventional fuse.

Conclusion

Compared with other fuses, an eFuse IC is very suitable for application in biomedical equipment. Though it costs higher than conventional methods, the semiconductor control is accurate and fast, which is promising in near future.

Reference

[1]https://toshiba.semicon-storage.com/tw/semiconductor/knowledge/e-learning/efuse-ics/what-is-the-semi-conductor-fuse-eFuse-IC.html

[2]https://toshiba.semicon-storage.com/tw/semiconductor/knowledge/e-learning/efuse-ics/advantages-of-Semiconductor-fuse-eFuse-IC-1.html

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