eFuse: Safety Certification and why it Matters

Today there are numerous standards that dictate product safety in the world of electronics. Two organizations that define and audit companies' compliance to these safety standards are Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC). The UL Mark of compliance is critical for the success of a product in several markets. The safety and reliability that comes with UL Recognized devices is so important that large retailers and insurance companies may even require certain safety-related standards to be met before they will endorse or sell an electronic product. To get certified, manufacturers design more robust and reliable products which are safer to use in hazardous environments. The product evaluation process for obtaining the UL Mark takes several steps. As UL says, "it is easier to design a product with UL requirements in mind than to redesign a product to meet a set of requirements."

Figure 1. UL Recognition Mark

One simple way to design your product with the UL Mark in mind is by selecting components that have already been assessed by UL. Designing with UL Recognized components can help prevent long debug cycles that could result from failing UL evaluation. These components help narrow down the source of the failure in the design of the product, speeding up UL evaluations and ultimately getting your product to market faster. The Texas Instruments (TI) Power Switches portfolio provides multiple options for safety-certified devices. Specifically, TI's electronic fuses (eFuses) portfolio are robust power path protection devices that are UL 2367 Recognized and IEC 62368-1 Certified.

TI's Certified eFuses

eFuses are integrated power path protection devices that are used to limit circuit currents and voltages to safe levels during fault conditions. The devices offer many benefits to a system and can include protection features that are often difficult to implement with discrete components. An eFuse embeds various functions to protect a system against inrush current, overcurrent, input overvoltage, reverse current, reverse polarity, and short-circuit faults. Unlike discrete fuses and PTCs, an eFuse has accurate current limiting, is faster, and can 'repair' itself without user intervention. Figure 2 shows a simplified block diagram of an eFuse.

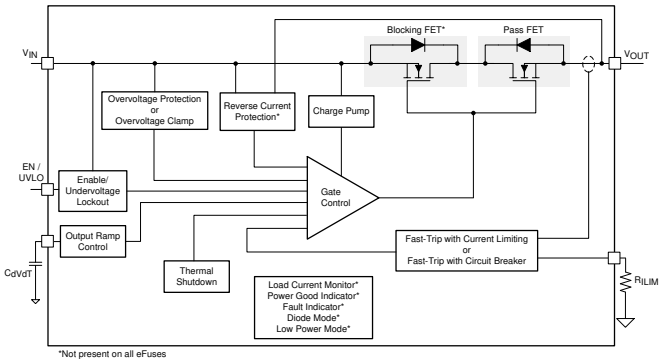

Figure 2. Simplified eFuse Block Diagram

UL 2367: Standard for Solid State Overcurrent Protectors

The robustness of the current-limiting protection feature in eFuse devices is tested during the UL 2367 evaluation process. UL 2367 recognizes TI's eFuse as a Solid State Overcurrent Protector. The tight current limiting evaluated during UL 2367, prevents issues such as fires, overheating, bus droop, and supply stress during overloads and startups. eFuses are evaluated to the maximum current-limit level specified in the product specific data sheet. For example, TPS2595, an 18-V, 4-A eFuse is tested to 4.42 A maximum. This accurate current-limiting (or output power-limiting) function simplifies system design by complying with end-equipment critical safety standards. The maximum current tested to for each UL 2367 certificate is noted in the data sheet, Figure 3 shows an example for the TPS2595 device.

Figure 3. TPS2595 UL 2367 Data Sheet Specifications

UL 2367 Recognition – File No. E169910

- R_{ILM} >=487 Ω (4.42 A maximum)

IEC 62638-1: Hazard-based standard for Audio/video, information and communication technology equipment

A common certification that applies to several electronic products is IEC 62368-1. This standard replaces the previously applicable IEC 60950-1. IEC 62368-1 specifies the safety of electrical and electronic equipment within the field of audio, video, information and communication technology, and business and

office machines with a rated voltage not exceeding 600 V. Examples of products are TVs, monitors, or mobile phones. TI's portfolio includes some eFuses certified to IEC 62368-1, in which the devices are subjected to a Safe During Single Point Failure Test. As per IEC 62368-1 Ed 2_0b_2014, “Components and subassemblies that comply with their respective IEC standards do not have to be tested when such components and subassemblies are used in the final product.” Therefore, if you choose one of TI’s IEC 62368-1 certified eFuses, you can usually bypass further testing of the device when your final product is evaluated for IEC 62368-1 compliance.

Examples of System Benefits With Certified eFuses

In addition to being a pre-certified component for the IEC 62368-1 system certification, eFuses can help ease certification to numerous other system-level standards. For example, household appliances sold in Europe must pass IEC60335-1, while home appliances sold worldwide must pass UL 60730. As discussed in the *Designing Low-Power Circuits (LPCs) using an eFuse for Household and Similar Appliances Application Report*, the two standards, IEC 60335-1 and UL 60730 have a lot in common including a shared definition of a Low-Power Circuit (LPC). For a node to be qualified as a Low-Power Point, the maximum power available at the node should not exceed 15 W. To obtain a maximum power limit of less than 15 W, the current limit of the TPS2596 eFuse for example, can be set such that the product of current limit (I_{LIM}) and maximum input voltage ($V_{IN(MAX)}$) is less than the required power limit setting of 15 W. One of the main features of TI’s eFuse is adjustable current limiting which is tested and verified for reliability when the devices are certified to UL 2367.

Another example is IEC 61010-1, which specifies the safety requirements for electrical equipment for measurement, control, and laboratory use. In section 9.4, the protection against the spread of fire requires that the maximum output power be limited to < 150 W. TI’s TPSx663 devices integrate adjustable output power limiting (P_{LIM}) functionality that simplifies and enables compliance to standards such as IEC 61010-1 and UL 1310. This can apply to various factory automation and control end equipments. In addition, some of the industrial systems use two eFuse devices in series to meet UL Class 2 power requirements such as protection during IN to OUT short failure mode.

A third example is the Medical standard IEC 60601-1 that is required for equipment used in an oxygen-rich environment. Section 11.2.2 details the maximum allowable power for resistive, capacitive, and inductive loads. TI’s eFuses with robust power limiting can again be easily used with the assurance to operate within the limits specified in UL 2367.

Based on the requirements in the specific system certification, you can likely find a current-limiting eFuse to fit your needs. Table 1 highlights a few of TI’s most popular eFuse devices.

In conclusion, a UL Recognized product is one that is deemed robust and compliant to certain standards by an unbiased, third party. These standards help ensure an electronic product is safer to use in environments such as households, factories, and hospitals where safety can be critical. To ease the UL evaluation process it is best to design with UL Recognized components. TI's eFuse products are designed with UL-certification-in-mind; this is an example of TI’s continued commitment to quality and reliability. See our eFuse product folders for easy access to each devices safety certificate and start simplifying your certification process today with TI’s safety-certified eFuses.

Table 1. TI's eFuse Portfolio

Device	Description	Recommended Voltage Range	Maximum Current	Typical R_{ON}	Package	Safety Certifications
TPS2595	Overvoltage or undervoltage clamp, QOD using FLT pin, adjustable current limit	2.7 V to 18 V	4 A	34 mΩ	SON	UL 2367 IEC 62368-1
TPS2596	Accurate current monitor, fast overvoltage protection, lowest adjustable current limit	2.7 V to 19 V	2 A	89 mΩ	SOIC	UL 2367 IEC 62368-1 pending
TPS25942	Back to back FETs, status monitoring, thermal shutdown, internal reverse current blocking	2.7 V to 18	5 A	42 mΩ	QFN	UL 2367 UL 60950
TPS25982	Lowest Ron circuit-breaker device, accurate load monitoring, adjustable transient fault management	2.7 V to 24 V	15 A	2.7 mΩ	QFN	UL 2367 IEC 62368-1
TPS2662	Back to back FETs, input and output reverse polarity protection, adjustable current limit	4.5 V to 60 V	800 mA	478 mΩ	SON	UL 2367 IEC 62368-1
TPS2660	Reverse polarity protection, current sense output, adjustable current limit	4.2 V to 55 V	2 A	150 mΩ	SOP and QFN	UL 2367 IEC 62368-1
TPS1663	Power limiting, overvoltage cutoff or voltage clamping functionality	4.5 V to 60 V	6 A	31 mΩ	SOP and QFN	UL 2367 IEC 62368-1
TPS2663	Power limiting, surge protection, overvoltage protection, B-FET driver	4.5 V to 60 V	6 A	31 mΩ	SOP and QFN	UL 2367 IEC 62368-1

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