GLOSSARY

Accuracy – the maximum deviation from the specified under/over voltage protection levels.

Auto-retry – an auto-retrying device will turn itself back on after a thermal shutdown once the die temperature is below the hysteresis value.

Bias current – the current needed by the eFuse itself to maintain operation.

Overload current limit, or current limit trip-point – the eFuse reacts to overcurrent events by reducing the conductivity of the pass element once the current exceeds this limit.

Short circuit current – when a strong overload occurs and the output voltage drops as a consequence, the device limits the current to a level below the regular current limit.

dV/dT – this refers to the internal circuitry that controls the output voltage rise at turn-on. The external dV/dT pin allows the user to extend the time beyond the pre-configured value.

Enable-fault – the enable-fault pin is a dual-function pin: it lets the user enable and disable the device, and at the same time provides the device status through a three-state logic.

Gate driver – to protect the supply and pass element, the STEF01 includes an internal charge pump to drive an external MOSFET that prevents reverse currents and large transient voltages which may occur during high-current limiting.

Hysteresis – to prevent an auto-retrying device from repeatedly turning ON and OFF after a thermal shutdown, the device only turns back on once the temperature has dropped by the hysteretic value.

Latch – when a thermal fault occurs, the device will remain OFF until the power or enable-signal is cycled by the user.

Output Voltage Clamp – if the input voltage exceeds the pre-defined voltage clamp value, the internal protection circuit ensures the output voltage does not rise above this preset value.

Pass element – the voltage and current pass through a low-resistive power MOSFET which can be controlled to limit the output current and voltage in reaction to fault conditions.

Power dissipation – during normal operation, the power dissipated by the device depends on the pass element's RDS(on) and the load current. When voltage/current is regulated, which happens during start-up and in case of faults, the excess power is dissipated in the form of heat. In persistent faulty conditions, this heat shuts the device down as a consequence of thermal protection.Thermal design and correct soft-start configurations are important to prevent unwanted shutdowns, which are most likely to occur during start-up phases or in high and continuous current conditions.

Power Good (PG) – a signal to indicate that the output voltage is very close to the input and that no current/voltage limitation is in place. It can be used for power-sequencing, reset-triggering, and more.

Soft Start (SS) – a Soft Start is a controlled delivery of the output power , which minimizes inrush currents, thus protecting the power supply from overloading. The Soft Start time can be extended by adding a capacitor to the dV/dT pin.

Thermal shutdown – during a persistent fault, the eFuse die will heat up. Once the shutdown temperature (typically 175°C) is reached, the device will turn off the internal pass element and go in latch or auto-retry state.

UVLO (Undervoltage lockout) – the UVLO makes sure the device does not turn on until the supply voltage is high enough, thus contributing to the eFuse's predictable and reliable performance.

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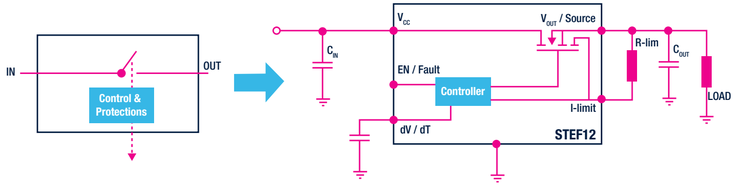
eFuse (electronic fuse) Quick reference guide

Ensuring safer designs and more efficient applications

HOW DOES AN eFuse WORK ?

An eFuse is a low-resistance switch connected in series to the main power rail and controlled by logic circuitry to protect loads and power supplies. Smaller, faster and more efficient than conventional fuses or polymeric PTCs, eFuses detect and react to overcurrent and overvoltage conditions, and do not require replacement after a fault event.



When an overload or short-circuit condition occurs, the eFuse limits the current to a pre-defined safe value. When an overvoltage condition occurs, the eFuse clamps the output voltage to a safe level,thus protecting the load from abnormalities caused by malfunctioning power supplies.

The eFuse disconnects the load from the power supply if fault conditions are persistent. Depending on the version, the device operates either in latch-off mode, which means it is switched-off and must be re-armed manually, or in auto-retry mode where the device will automatically re-start.

KEY BENEFITS OF ELECTRONIC FUSES

Quick and intelligent response to faults

Unlike conventional fuses, which are based on the principle that a conductor will overheat and melt during an overload condition, the eFuse only clamps the output voltage and/or limits the throughput current, thus allowing the device to be supplied correctly, before eventually disconnecting the load in case of persistent failure. This prevents load and supply damage from occurring and avoids false triggering caused by transient conditions. Moreover, in applications powered by DC buses, eFuses reduce the bus droop due to faulty loads, avoiding the propagation of nuisance or undervoltage to other loads connected to the same bus.

Reduced maintenance

Since eFuses do not sacrifice their pass element, they can immediately be reset with a signal from the system by either cycling the supply power or by simply waiting, if auto-retry is used. The equipment's uptime is maximized and the cost and complexity of maintenance are reduced.

Inrush current control

Inrush current conditions can occur during start-up or hot-plugging. eFuses ramp the output voltage up in a controlled manner to prevent large inrush currents from overloading the power supply. This feature is crucial when multiple loads are supplied by a single power supply.

Flexible application design

Every eFuse can be programmed and tailored to your specific needs. Most eFuses allow users to set the current limit and start-up time. The undervoltage lockout and output clamp levels as well as the device's operating mode (latch-off or auto-retry mode) can also be configured on certain part numbers.

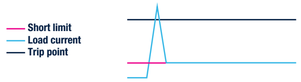
KEY FEATURES

Output voltage clamping

Each eFuse has a predefined maximum output voltage safe value. If the input voltage exceeds this value, the eFuse clamps the output voltage to the preset value and allows the device to operate without damaging the load or system.If the overvoltage is persistent, the eFuse disconnects the load.Most eFuses have a pre-set voltage clamp value. The STEF01 allows users to configure it.

Current limiting

When an overload condition occurs, the eFuse reduces the conductivity of the internal pass element to effectively limit the current to a preconfigured value. If a strong overload or short circuit occurs, the device enters the foldback current limit, and eventually disconnects the load, thus protecting the power supply. This value is usually configured using an external resistor.



Undervoltage lockout

The undervoltage lockout feature disconnects the load from the supply if the input voltage is lower than a preset minimum. By avoiding issues caused by too low supply voltage such as wrong voltages from bandgap references, incorrect control signals in logical circuitry, and transistors being only partially ON or OFF, the undervoltage lockout increases system predictability.The STEF01 allows users to set the undervoltage lockout threshold between 8 V and 45 V.

Turn-on delay/Soft start

The eFuse provides a defined and predictable ramp-up of the output voltage during start-up, to ensure the inrush current is maintained within safe confines and protects both the load and the power supply. The soft start duration can always be easily configured by an external capacitor.

Enable/Fault pin

The Enable/Fault pin is a dual-function pin that allows users to manually turn the output off and to read the current state of the device. The eFuse can be reset by toggling this pin after a thermal shutdown.The pin can be used as a regular enabling pin and can be connected to a monitoring circuit to notify thermal shutdown events. It can also be connected to the Enable/Fault pins of other eFuses, to achieve a simultaneous Enable/Disable operation for all devices.

eFuses PORTFOLIO OVERVIEW

STEF01

HTSSOP14

- **STEF01** protects any bus voltage between 8V and 48V, with an adjustable output clamp voltage ranging from 10 V to 52 V
- Maintains continuous currents up to 4 A
- Features only 30 mΩ of ON-resistance
- Offers full control of the turn-on time, the undervoltage lockout threshold, the current limit and the auto-retry function
- An internal gate driver allows an external MOSFET to be connected to block reverse currents

STEF12 / STEF12E

DFN10 (3x3mm)

- **STEF12** is designed for 12 V buses
- Safely clamps the output voltage to 15 V
- Maintains a continuous current up to 3.6 A
- Features 53 mΩ (STEF12) / 45 mΩ (STEF12E) of ON-resistance
- Offers full control of the turn-on time to limit inrush currents

STEF05 / STEF05D

DFN10 (3x3mm)

- **STEF05 and STEF05D** are designed for 5 V buses and safely clamp the output voltage to 6.65 V,
- Maintains a continuous current up to 3.6 A
- Features only 40 mΩ of ON-resistance
- Both devices support controlled turn-on time to safely limit the inrush current
- **STEF05D** supports a different relationship between current limit and programming resistor so it is compatible with a wider range of applications

STEF05L


DFN10 (3x3mm) Flip Chip 9

- **STEF05L** clamps the voltage to 6.1 V
- Maintains a current up to 3.6 A / 2.5 A (DFN10/Flip-Chip 9)
- Features only 40 mΩ / 25 mΩ of ON-resistance
- Offers full control of turn-on times to limit inrush currents
- Available in both latching and auto-retrying versions

STEF4S

DFN10 (3x3mm)

- **STEF4S** can be configured to protect 3.3 V or 5 V buses, as it clamps the output voltage to 3.8 V or 5.5 V, depending on the selected voltage level
- Features only 40 mΩ of ON-resistance
- Ultra-low quiescent current of 50 µA makes it suitable for battery-powered applications, such as data-storage units in laptops
- Offers full control of turn-on times to limit inrush currents

STEF033


DFN10 (3x3mm) Flip Chip 9

- **STEF033** is designed for 3.3 V buses and safely clamps the output voltage to 4.5 V in overvoltage situations
- Maintains continuous currents up to 3.6 A / 2.5 A (DFN10/Flip-Chip 9)
- Features only 40 mΩ / 25 mΩ of ON-resistance
- Available in both latching and auto-retrying versions
- Offers full control of turn-on time to limit inrush currents

>= 12 V **5 V** **3.3 V**