Scalable Current-Sharing E-Fuse Solution

By Jason Bone at MPS

In typical hot-swap or electronic fuse (e-fuse) applications, great care must be taken when selecting the MOSFET used to ensure that the safe operating area (SOA) of the MOSFET is not exceeded during a soft start (SS) turn-on. Even if multiple MOSFETs are paralleled, the soft-start condition causes large amounts of thermal stress.

Generally, when using discrete MOSFET hot-swap and e-fuse applications, it is assumed that only one MOSFET is conducting the entire soft-start current. This is due to the variation in the gate threshold voltage of each MOSFET. Therefore, all the power loss is in one device even though there may be multiple MOSFETs in parallel. This requires oversizing the MOSFET rating and package size, which drives up the PCB area. With typical hot-swap/e-fuse applications, a precision current sense resistor and a controller is needed to provide SS timing, temperature protection, and over-current protection (OCP).

The MPS MP5921 provides an innovative hot-swap/e-fuse application with a simple and stackable building block. The MP5921 has a built-in MOSFET, current sensing, temperature sensing, soft-start ramp control, and advanced protection features. The use of advanced monolithic processes allows for user-friendly implementation for hot-swap and e-fuse solutions (see Figure 1).

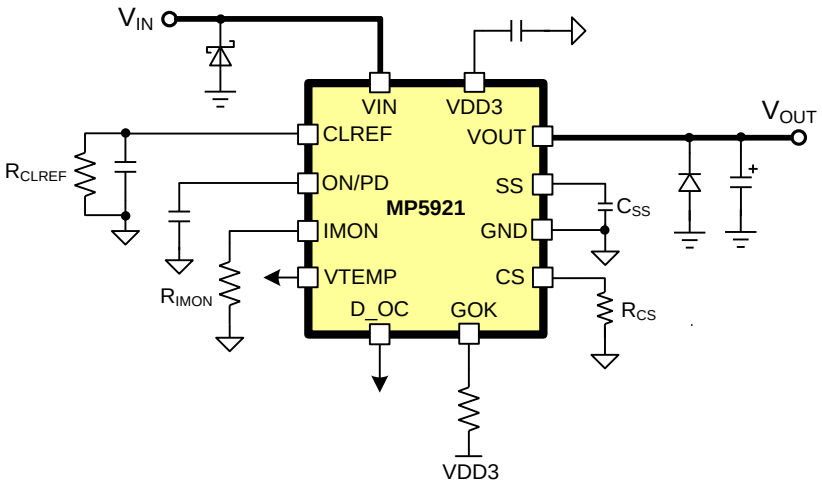

Figure 1: Hot-Swap/E-Fuse Application Components

The MP5921 uses an advanced monolithic process to monitor and drive the internal MOSFET actively during the soft-start process to ensure the SOA of the MOSFET. Using this monolithic process, the MP5921 can measure the current flowing through the internal MOSFET accurately.

With the ability to monitor the current through the internal MOSFET, multiple MP5921 devices connected in parallel actively balance the current flowing through each device during the soft-start condition. This ensures that each device carries the soft start current equally, and no one device carries the full soft-start load current. With the soft-start current balanced among the devices in parallel equally, the risk of violating the SOA of the MOSFET is reduced greatly, and the thermal energy is more evenly distributed on the PCB.

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

Figure 2 below shows the current sharing of three MP5921 devices in parallel during a soft start with a DC load. All three devices in parallel share the soft-start load current evenly.

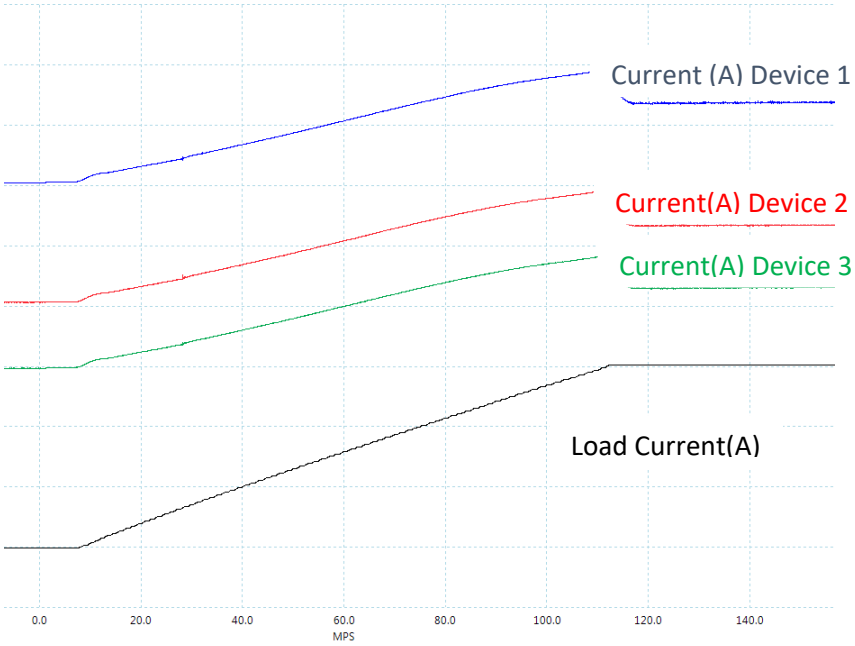

Figure 2: Three MP5921 Devices in Parallel

If the traces for the individual currents are set on the same origin point, it can be seen that they overlap exactly (see Figure 3).

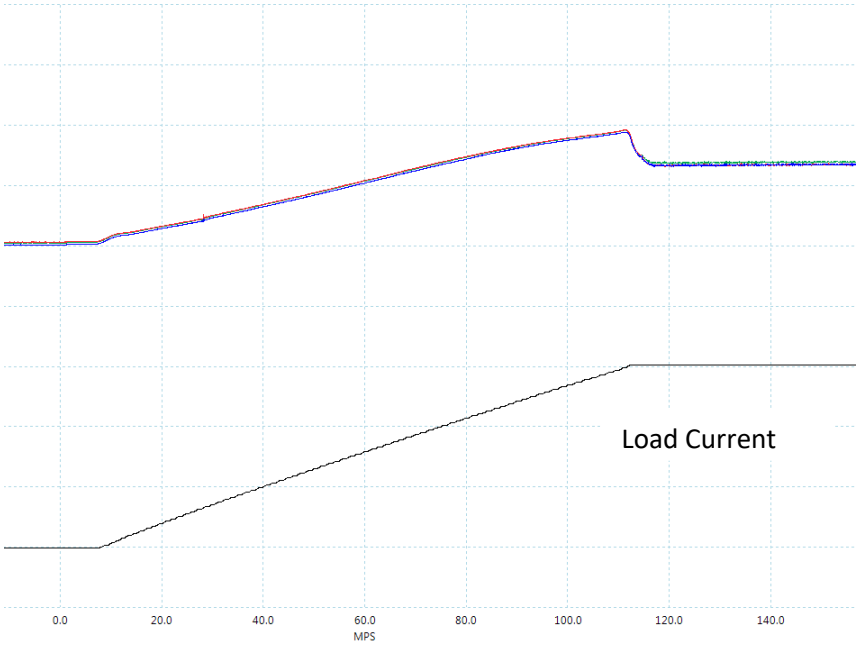

Figure 3: Currents with Same Origin Point

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

The MP5921 can be scaled to support any current range needed for hot-swap and e-fuse solutions. With a 60A current rating in a 4mmx5mm package, the MP5921 provides an extremely dense hot-swap/e-fuse solution. Each MP5921 has built-in protection features that monitor for damaged MOSFET, over-temperature conditions of the internal MOSFET, soft-start watchdog timer, and over-current protection.

The MP5921 also has a built-in short-circuit protection (SCP) feature that can disable the internal MOSFET within 200ns of a short detection. This quick disabling function prevents a large build-up of current on the PCB where output shorts occur.

The MP5921 provides a robust and user-friendly solution for space-critical designs that can be scaled to meet the design requirements of all types of hot-swap/e-fuse applications.

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.