Technical Article

Simple Methods for Limiting Current Using an Integrated MOSFET

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Currents often have to be limited in electronic circuits. For example, in a USB port excessive current flow must be prevented so that the electrical circuit can be reliably protected. Likewise, in a power bank, battery discharge must be prevented. Discharging with too high of a current can lead to an impermissibly high voltage drop in the battery and an insufficient supply voltage to the downstream device.

Thus, it is often necessary to limit a current flow to a specific value. Most power converters have overcurrent limiters to protect themselves from damage due to excess currents. In some DC-to-DC converters, the threshold can even be adjusted.

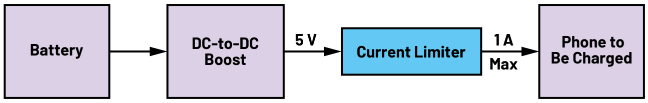

Figure 1. For current limiting in a power bank with an output current of 1 A per port.

In Figure 1, a DC-to-DC boost converter with a built-in, possibly even adjustable, current limiter could also be used. In this case, the additional current limiter block could be omitted. However, there are also many applications in which no DC-to-DC converter is used in the power path. One example is when a voltage of 24 V is available in a system and the current flow in this line should be limited, but the load has to be operated at exactly 24 V. In this case, an additional current limiter block, as shown in Figure 1 in blue, can be used.

A current limiter circuit provides a solution to this problem. It comes from the family of protection modules, which includes, for example, hot swap controllers, surge protectors, electronic circuit protectors, and ideal diodes.

Most of these ICs on the market use external MOSFETs as switches for switching the current flow on and off, but also for limiting the current, in which case the switch works like a linear regulator. Such a switch must, however, ensure that the MOSFET is always operated within its safe operating area (SOA). If this is not the case, the semiconductor and thus the circuit will be damaged. Unfortunately, it's not always easy to select a suitable MOSFET and operate it in just such a way that it never leaves the SOA. The operating temperature, the voltage, the current, and especially the time are all factors that influence this. They all have to be right in order to ensure safe operation. Figure 2 shows an SOA diagram for a typical N-channel MOSFET. Operation of the MOSFET below the lines shown is permitted.

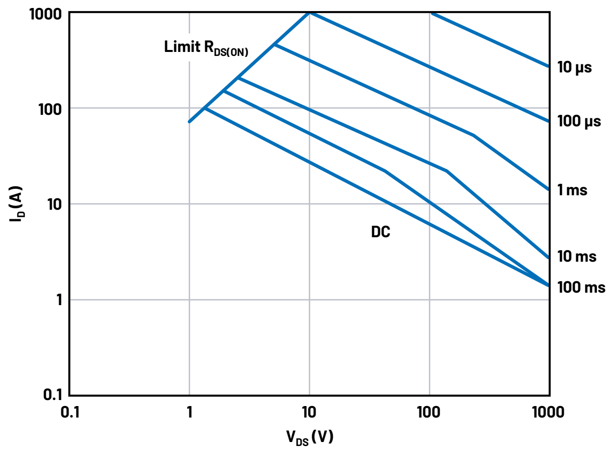

Figure 2. A typical SOA of a MOSFET.

Figure 3 shows a dedicated current limiter IC, the MAX17523 from Analog Devices. It has two MOSFETs that can limit current to a value between 150 mA and 1 A. If the current flow reaches the limit, it is either cut off and resumed after a certain waiting period, or the current flow is interrupted continuously until the next switch-on, or the current is limited through a reduction in voltage. The internal MOSFET is then operated in the ohmic region. This is then a type of linear regulator function. In each of these adjustable limitation modes, the internal MOSFET is always in its SOA and is not damaged. And no elaborate calculations or evaluations are required.

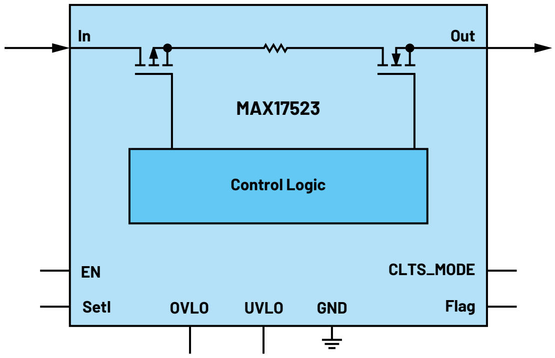

Figure 3. A simplified circuit diagram of a dedicated current limiter IC.

Limiting currents in a circuit is not a problem if suitable highly integrated ICs are used. It also makes sense to combine this type of circuit with a DC-to-DC converter if the converter doesn't have an adjustable current limiter.

About the Author

Frederik Dostal is a power management expert with more than 20 years of experience in this industry. After his studies of microelectronics at the University of Erlangen, Germany, he joined National Semiconductor in 2001, where he worked as a field applications engineer, gaining a lot of experience in implementing power management solutions in customer projects. During his time at National, he also spent four years in Phoenix, Arizona (USA), working on switch mode power supplies as an applications engineer. In 2009, he joined Analog Devices, where since then he held a variety of positions working for the product line and European technical support, and currently brings in his broad design and application knowledge as a power management expert. Frederik works in the ADI office in Munich, Germany.

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