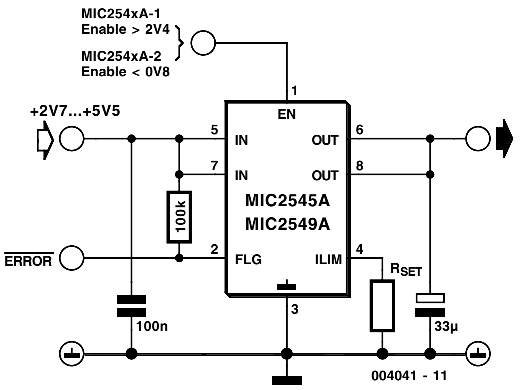
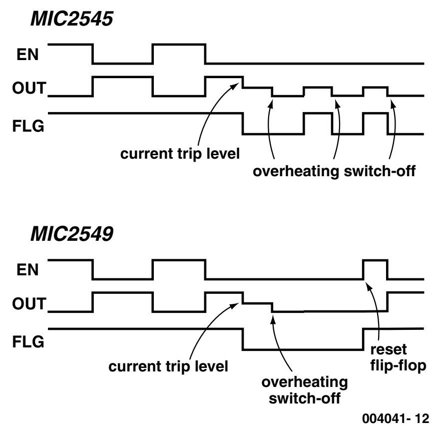
052 Switch ICs with Adjustable Current Limiting





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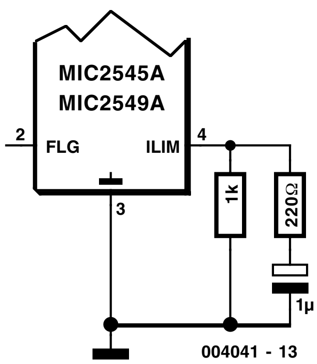
Transistors are often used for switching power supply voltages. MOSFETs are most often used, since they have low 'on' resistances, and they are also available for large currents. What a discrete transistor or MOSFET lacks are protective functions, such as current limiting and overtemperature protection.
The MIC2545A from Micrel can provide a solution to this problem. This MOSFET switch has programmable current limiting, as well as undervoltage and overtemperature cutouts. It works with input voltages between +2.7 V and +5.5 V. With a typical 'on' resistance of only 35 mΩ, this IC can switch up to 2.5 A in a DIP8, SO8 or TSSOP14 package. It also includes a soft-start circuit, which limits the switch-on current for the first two milliseconds. An integrated charge pump generates the gate voltage needed for switching the MOSFET.
The current limiting level can easily be set by an external resistor between the ILIM pin and earth. The resistance value can be calculated using the following simple formula:

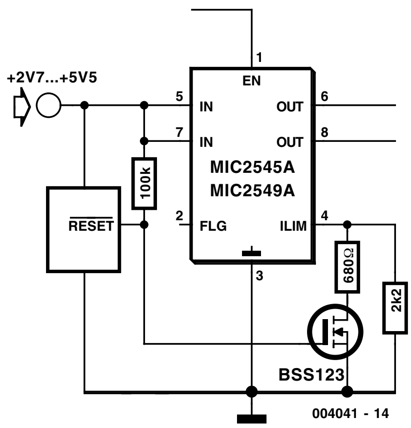
$R_{set} = 230 / I_{lim}$

where the current I_{lim} is in ampères and the resistance R_{set} is in ohms. For a maximum current between 0.5 and 2.5 A, the resistance thus lies between 460 Ω and 92 Ω. In case of a short circuit, the current is limited to around $1.6I_{lim}$.
The MIC2454A is controlled via an Enable input. In order to satisfy all possible applications, it is available in two versions.

The MIC2454A-1 switches on the MOSFET when the Enable input is High (V_{in} > 2.4 V), while the MIC2454A-2 version switches on the MOSFET when the Enable input is Low (V_{in} < 0.8 V). The IC typically draws 90 µA when the switch is enabled, but it draws less than 1 µA in the switched-off state. This means that it can also be used for switching on battery-operated equipment. The low operating current consumption of the MIC2545A makes a mechanical battery switch unnecessary.
The operating state of this high-side switch is indicated by an open-gate flag output. An error condition (overcurrent, undervoltage or overtemperature) in signalled by a low resistance at this output, so that an external pull-up resistor is pulled to earth.

The MIC2545A switches on again after an overtemperature cutout as soon as the chip temperature has dropped sufficiently. However, in some cases it may be desirable to save the overtemperature state and prevent the output from automatically being switched on again after an overtemperature excursion. In such cases, the derivative type MIC2549A can be used. It contains a flip-flop, which must be reset by deactivating the Enable signal before the switch can be re-enabled. The MIC2549A is also available in two versions, namely the MIC2549-1 with active high Enable and the MIC2549-2 with active low Enable.
The overtemperature cutout is triggered at a chip temperature of approximately 130 °C. The switch can be re-enabled after the temperature drops below 120 °C.





The MIC2545A has an interesting feature that allows the switch-on current for a following assembly to be increased. If a series RC combination is connected in parallel with R_{set}, the effective resistance connected to the ILIM pin is reduced for a short time immediately after switch-on. During the charging time for the capacitor (corresponding to the time constant of the RC combination, $t = RC$), the two resistors are connected in parallel, and the current limit value is thus increased. Once the capacitor is charged, only the normal resistor is effective. An additional interesting possibility is to switch the current limiting level to a different value by means of a transistor, which can for example be driven by a reset IC or a supply voltage monitoring IC. This allows the switch-on current to be limited to a lower level. As long as the input voltage is not high enough, the current limiting level is switched to a low value, since $\overline{\text{RESET}}$ is Low and the FET is cut off, so that only one of the two resistors is effective. As soon as the input voltage is

$R_{SET} = 230\ V/I_{LIM}$
$0.5\ A \leq I_{LIM} \leq 2.5\ A$

$I_{LIM}|_{t<RC} = 230\ V / (1\ k\Omega\ ||\ 220\ \Omega) \approx 1.3\ A$
$I_{LIM}|_{t>RC} = 230\ V / 1\ k\Omega \approx 0.23\ A$
$RC = 220\ \Omega \cdot 1\ \mu F = 220\ \mu s$

$I_{LIM} = 230\ V / 2.2\ k\Omega \approx 100\ mA$
$I_{LIM} = 230\ V / (680\ \Omega\ ||\ 2.2\ k\Omega) \approx 440\ mA$

OK, the $\overline{\text{RESET}}$ signal goes High and switches on the FET. Both resistors are now connected in parallel, and the current limiting level lies at a higher value. You can obtain more information at *www.micrel.com*.

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