TPS25200 eFuse Module

Features

- Programmable current limit up to 2.9A
- 60mΩ(typical) MOSFET switch
- Automatic startup[1]
- 8ms deglitch
- Supports 3V~5V input

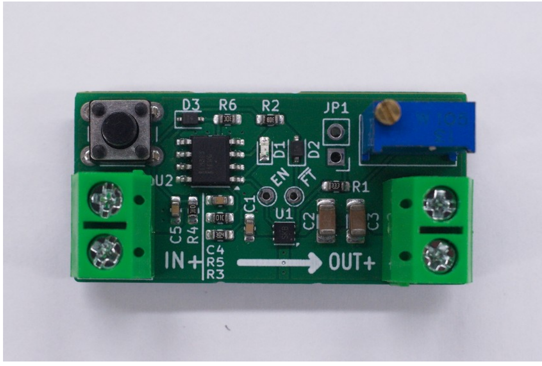


Figure 1: The assembled module.

This module is based on the TPS25200 eFuse IC from Texas Instruments. This module protects the power supply or battery from over loading when the load draws too much current or is accidentally shorted. When the current exceeds the programmed limit for more than 8ms, the eFuse will shutdown the circuit. The eFuse can be reset with a push button.

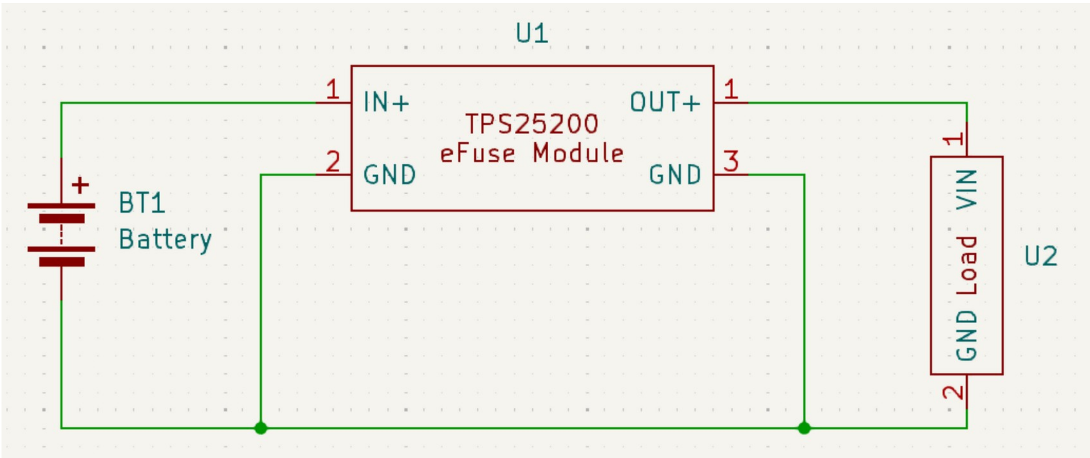


Figure 2: Typical application of the TPS25200 eFuse Module.

Pin Configuration

This module has 4 I/Os:

Pin name	Description
GND(x2)	Ground connection for both input and output. The two grounds are connected.
IN+	Input to the eFuse module. This pin is connected to the power supply or battery.
OUT+	Output of the eFuse module. This pin supplies power to the downstream circuit.

1 The automatic startup function requires the input to rise fast enough. The input should rise with a time constant of at most 100µs.

Setting & Operation

To set the current limit, tune the variable resistor $RV1$ according the following equations. The unit for resistance is kΩ and the unit for current is mA in the following equations. The resistance of $RV1$ can be measured through JP1.

$$I_{OSmax} = \frac{96754}{(RV1 + 33)^{0.985}} + 30 \qquad \text{(Equation 1)}$$

$$I_{OSnom} = \frac{98322}{(RV1 + 33)^{1.003}} \qquad \text{(Equation 2)}$$

$$I_{OSmin} = \frac{97399}{(RV1 + 33)^{1.015}} - 30 \qquad \text{(Equation 3)}$$

Equation 1 shows the maximum current-limit threshold. The eFuse is guaranteed to shutdown when the current is above this threshold. Equation 2 shows the nominal current-limit threshold. Equation 3 shows the minimum current-limit threshold. The eFuse is guaranteed to not shutdown when the current is below this threshold.

Figure 3 shows a graphical method to determine the resistance, the procedure is described below:

1. Determine the target current-limit threshold.
2. Find the corresponding value of R_{ILM} in figure 3.
3. Calculate $RV1 = R_{ILM} - 33\text{k}\Omega$.

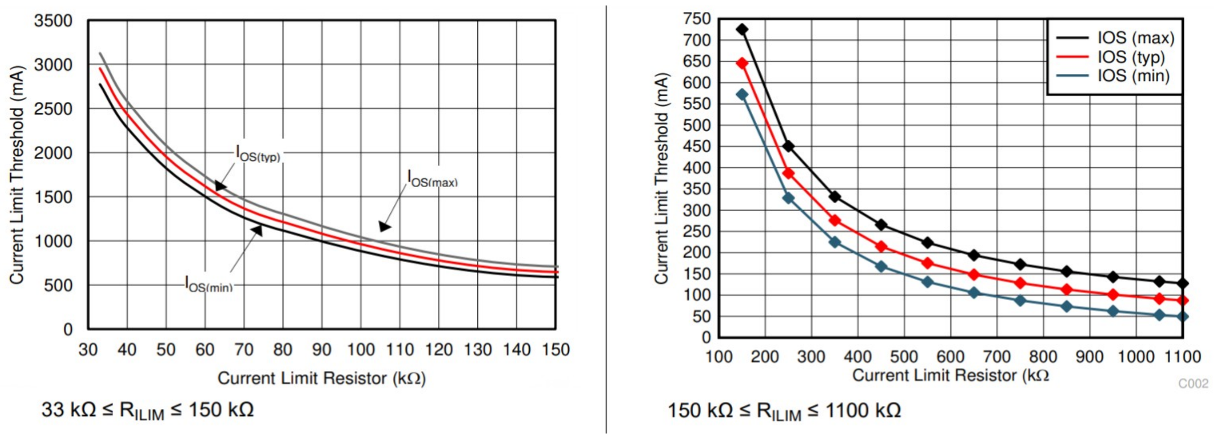


Figure 3: Current-limit threshold vs $R_{ILM} = RV1 + 33\text{k}\Omega$ (source: TPS25200 datasheet)

On this module, the TPS25200 eFuse IC is controlled by an LM393 comparator, when the output current exceeds the current-limit threshold, the fault signal will be latched and the eFuse is turned off. At the same time, the red LED on the module will light up to indicate a fault. To reset the module, remove the over-current/short event and press the push button.

Testing Data

1. Auto startup with capacitance at input

   The goal of this test is to verify the auto startup function of the eFuse module. The test circuit setup is shown in figure 4. The input of the eFuse module is connected to an RC circuit to simulate a slowly rising input voltage. The capacitance of $C1$ is varied from 1μF to 220μF, while the resistance of $R1$ is kept at 1Ω. The switch(a MOSFET in actual testing) is closed at $t = 0$ and the output response is recorded. The auto startup function is consider a "pass" if the output of the eFuse module is successfully turned on and rises to the same voltage as the input.

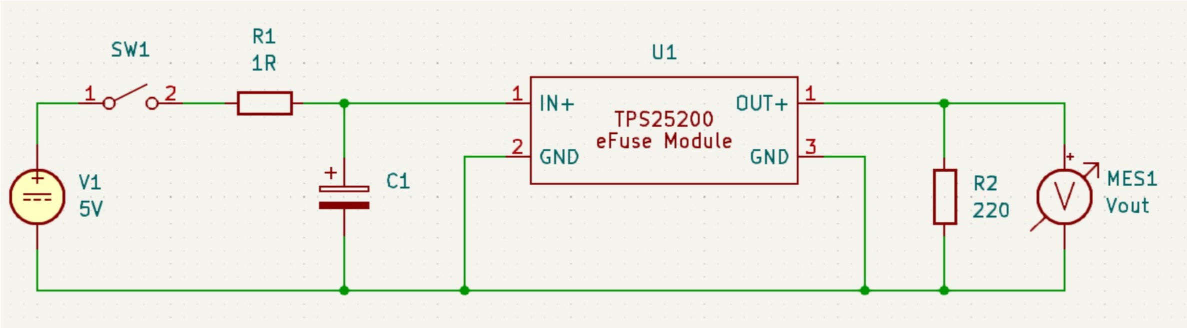


Figure 4: Testing circuit for verifying auto startup function.

R1	C1	Input time constant	Pass/Fail
1Ω	1μF	1μs	Pass
1Ω	10μF	10μs	Pass
1Ω	100μF	100μs	Pass
1Ω	220μF	220μs	Fail

The time constant of the input rise should be lower than 100μs for auto startup to function properly. If a slower input rise is used, the module need to be started up manually with the push button.

Figure 5 shows the response of the eFuse module during startup. The capacitance $C1$ is 100μF . There is a 3ms delay for the output of the eFuse module to turn on and the output voltage will match the input after 5ms.

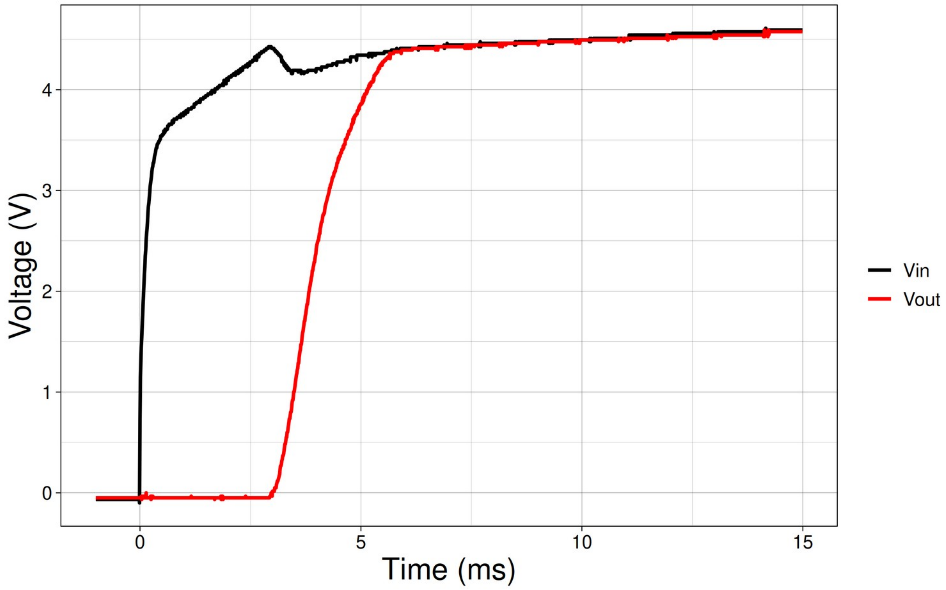


Figure 5: The response of the eFuse module during startup.

2. Response to short at output

   The output of the eFuse module is shorted with a MOSFET at $t = 0$ to simulate the response to an over-current event. Figure 6 shows the test circuit setup.

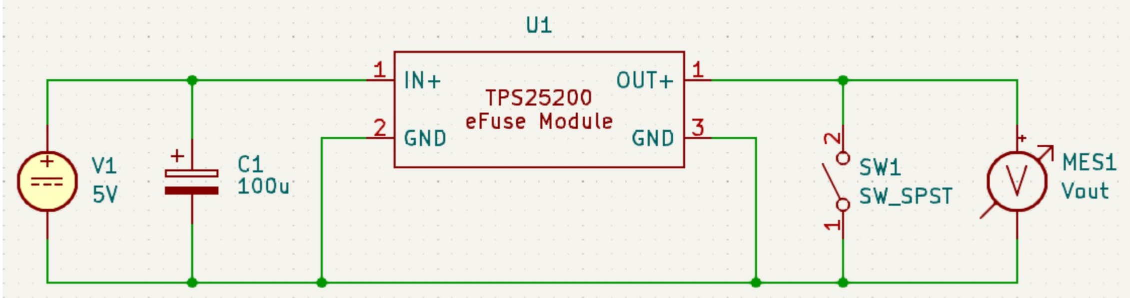


Figure 6: Testing circuit for response to short at output.

In figure 7, the output is shorted at $t = 0$ and the response of the eFuse module is recorded. The current will be clamped to the set current-limit for 8ms, and then eFuse will be totally shut down.

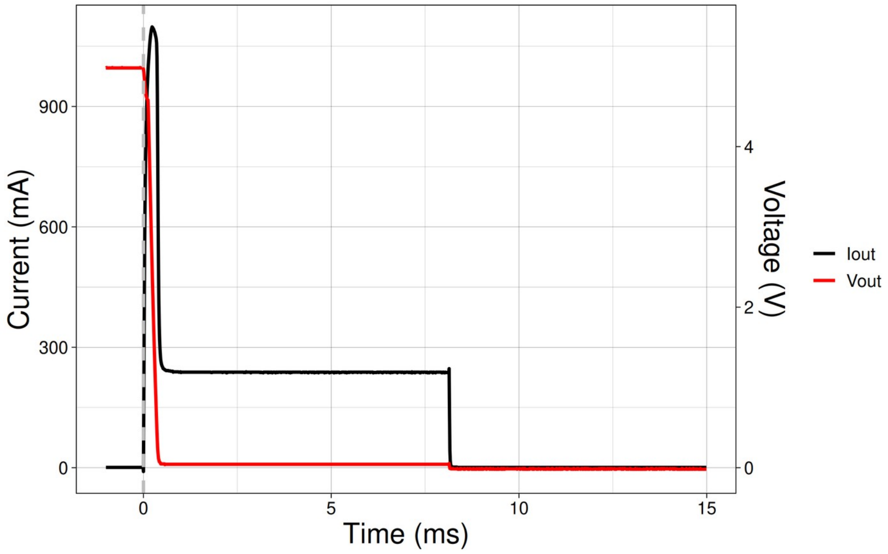


Figure 7: Output current and voltage when the output is shorted.

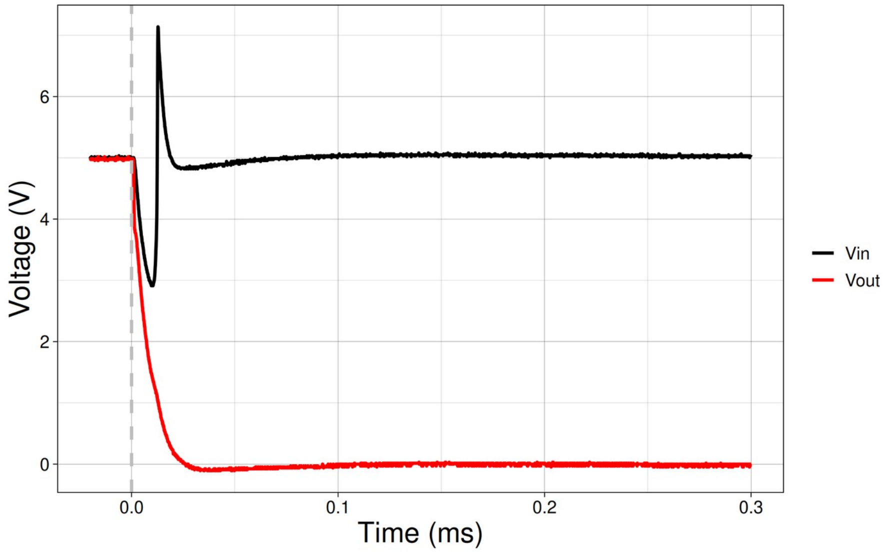


Figure 8: Input and output voltage when the output is shorted.

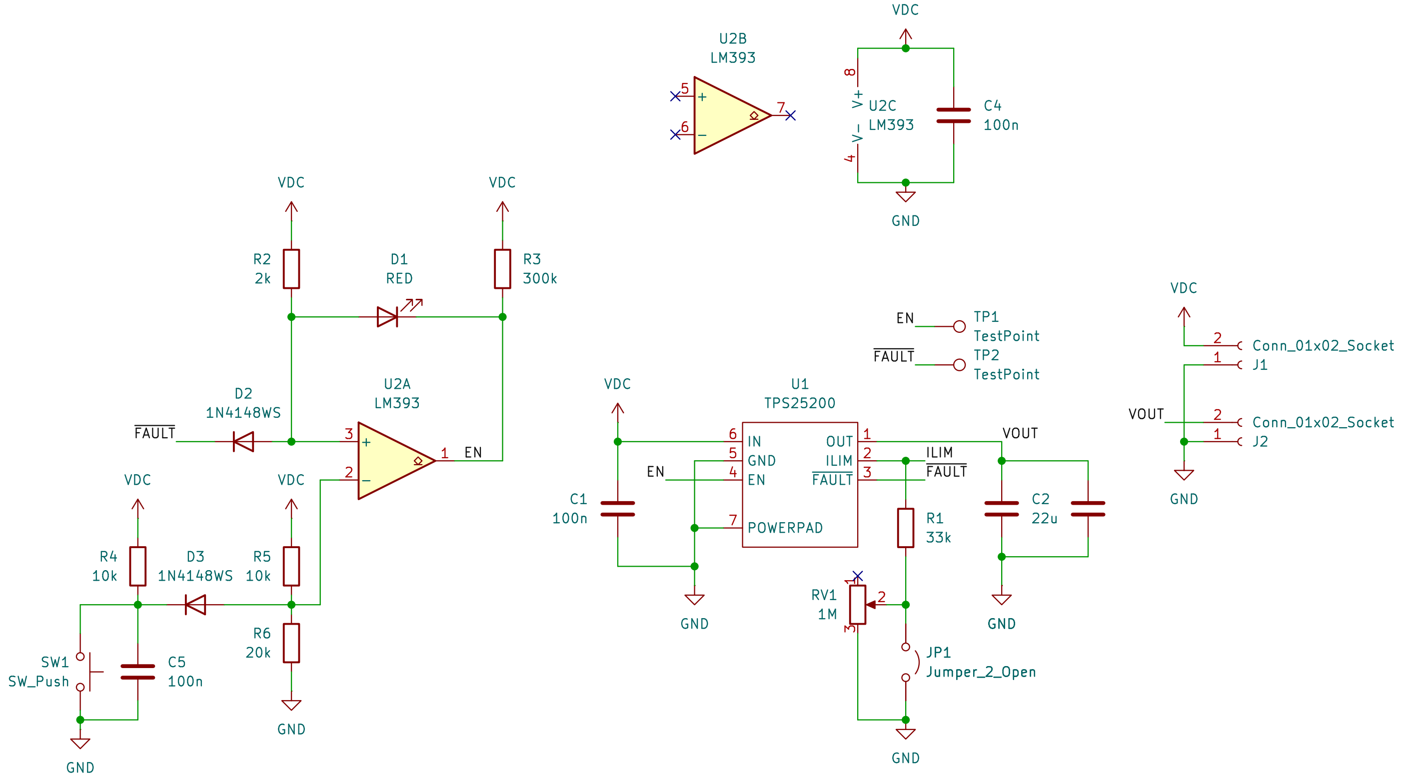
In figure 8, due to the large negative di/dt, parasitic inductance of the wiring between the power supply and the eFuse module will cause a surge in voltage at the input when the eFuse is shutting down. The magnitude of voltage spike is heavily dependent on the parasitic inductance between the power supply and the eFuse module, one way to reduce it is to twist the pair of wire from the power supply together.

List of Parts

Parts	Bare PCB	Full Kit
TPS25200 eFuse Module PCB	Included	Included
$1M\Omega$ potentiometer	Not included	Included(1x, soldered)
Push button	Not included	Included(1x, soldered)
Screw terminals	Not included	Included(2x, soldered)

Revision History

PCB Revision	Datasheet Revision	Description
1.0	1.0.0	Initial version.



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Title: TPS25200 eFuse Module

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