

Microchip Automotive Qualified LDOs Overview

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INTRODUCTION

At the present time, power management is a very important block in all electronic systems. The current trend among design engineers is to use simple and cheap solutions as their primary choice. Linear regulators meet all these criteria, making them a top pick for designers, even more so when it comes to Low-Dropout (LDO) regulators.

These types of power management devices are also being used in the automotive area, an important segment for the industry, so the ICs need to have automotive qualification (AEC-Q100).

AEC-Q100 is a failure mechanism-based stress test qualification for packaged circuits used in automotive applications. An AEC-Q100 qualified device means that the device has passed the specified stress test and ensures a certain level of quality. This automotive qualification is divided into four grades (0, 1, 2, 3), depending on the temperature range.

Grade	Ambient Operating Temperature Range
0	-40°C to +150°C
1	-40°C to +125°C
2	-40°C to +105°C
3	-40°C to +85°C

MICROCHIP AUTOMOTIVE LDO SOLUTIONS

In the last few years, Microchip Technology Inc. has released to the market new automotive qualified LDOs, such as MCP1790/1, MCP1792/3, MCP1799 and many more (see [Table 1](#) for comparisons between these automotive LDOs).

The following sections will present two new automotive LDOs which can sustain high-voltage transients on the input and are ideal for 12V to 48V input rails.

MCP1792/3

MCP1792/3 is a 100 mA, high-voltage, automotive LDO that was released on the market in 2019. These family devices are AEC-Q100, Grade 0 and PPAP-capable Low-Dropout linear regulators. The operating temperature range is -40°C to +150°C. The devices are capable of outputting 100 mA of current over the entire temperature range within the limit of power dissipation. The input voltage range of 4.5V to 55V makes them suitable for 12V to 48V power rails. The output voltage comes in standard, fixed V_{OUT} versions of 3.3V, 4.1V and 5V, and can sustain up to 70V input transient (see [Figure 1](#)).

These devices have a low UVLO threshold of 2.4V at shutdown, which makes them adequate for cold cranking conditions in automotive applications.

The MCP1792/3 device family has an ultra-low quiescent supply current of 25 μ A and an ultra-low shutdown quiescent supply current of 2 μ A, so it can be considered a low-power consumption LDO. The device itself has a ground current of 100 μ A typical, while delivering a maximum output current of 100 mA. These aspects are possible due to an innovative adaptive bias circuitry used to lower the power consumption at no load, and light loads, without compromising the dynamic response.

The device is protected from short-circuit events by current foldback function and from overheating by means of thermal shutdown protection.

Current foldback protection activates in a soft manner for an output short-circuit event that occurs in normal operation. When the current foldback block detects an increase in load current over the typical value of 230 mA, the output current and output voltage will start to decrease until the output current reaches a typical value of 10 mA.

The MCP1792/3 was tested using the AEC-Q100 test setup (see [Figure 2](#) for more details). The testing conditions require the use of very high parasitic inductances on the input and output. For cases like this, it is required to prevent the output voltage going below ground with more than 1V. Note that the V_{OUT} pin can generally withstand a maximum of $-0.3 V_{DC}$. This can be achieved by placing a Schottky diode with the cathode to V_{OUT} and the anode to ground. Thermal shutdown functionality is present on the device and adds to the protection features of the part. Thermal shutdown is triggered at a typical value of +175°C and has a typical hysteresis of +15°C. In addition, if a short circuit is present during power-up, the part will enter into current limit protection.

The device also features an adequate PSRR of 80 dB typical for low frequencies and of 55 dB for high frequencies.

MCP1792/3 is stable with ceramic output capacitors of 2.2 μF and comes in different packages: 3-lead SOT223 and SOT23A, and 5-lead SOT223 and SOT23.

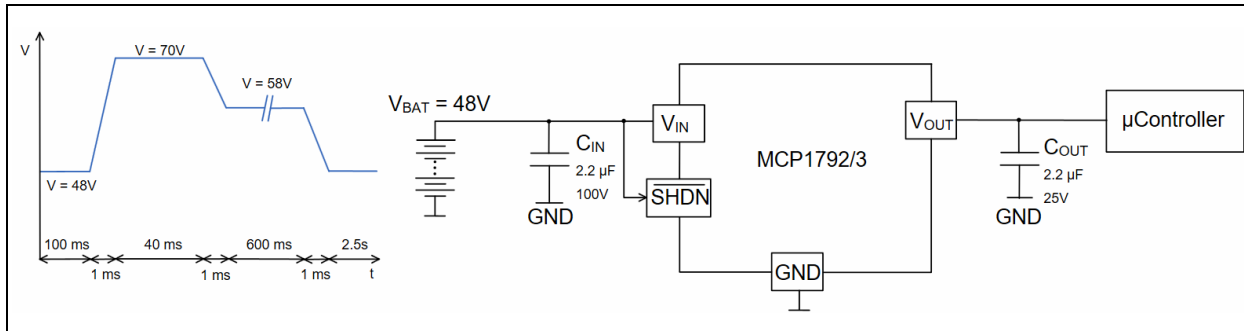


FIGURE 1: Typical Application for MCP1792/3.

MCP1799

The MCP1799 is an AEC-Q100, Grade 0 qualified LDO, capable of delivering 80 mA current over the entire operating temperature range of -40°C to $+150^{\circ}\text{C}$.

The input voltage range for this device is 4.5V to 45V, which makes it ideal in 12V to 36V power rails and in high-voltage battery packs. The device has a UVLO (Undervoltage Lockout) of 2.8V typical. The output voltage comes in two standard, fixed V_{OUT} versions of 3.3V and 5V.

The MCP1799 has an ultra-low quiescent supply current of 25 μA . The device itself has a ground current of 45 μA typical, while delivering a maximum output current of 80 mA.

The device is protected from short-circuit events by the current limit function and from overheating by means of thermal shutdown protection.

The MCP1799 was tested using the AEC-Q100 test setup (test conditions are the same with MCP1792/3 and can be read in the previous section). See [Figure 2](#) for more details. Thermal shutdown functionality is present on the device and adds to the protection features of the part. Thermal shutdown is triggered at a typical value of $+180^{\circ}\text{C}$ and has a typical hysteresis of $+22^{\circ}\text{C}$. If a short circuit is present during power-up, the part will enter into current limit protection.

The device also features an adequate PSRR of 70 dB typical for 100 Hz frequency.

MCP1799 is stable with ceramic output capacitors of 1 μF and comes in different packages: 3-lead SOT223 and SOT23.

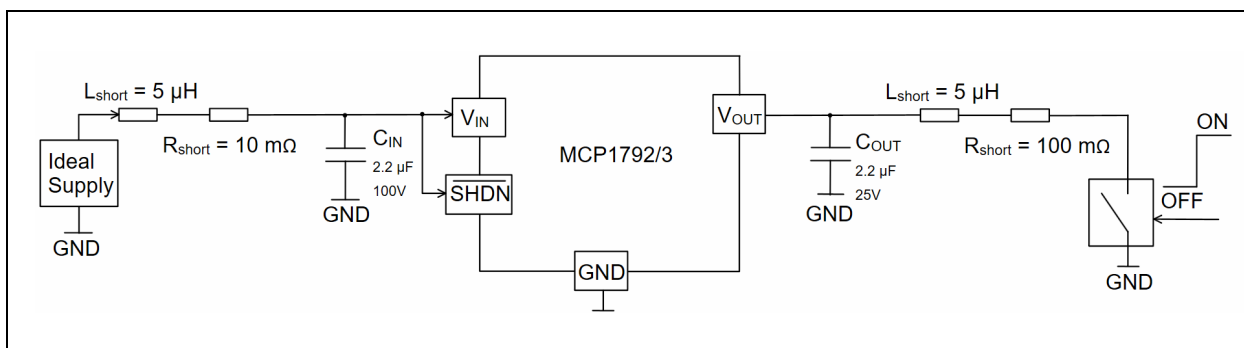


FIGURE 2: Short-Circuit Test Setup.

TOTAL SYSTEM SOLUTIONS WITH MCP1792/3 AND MCP1799

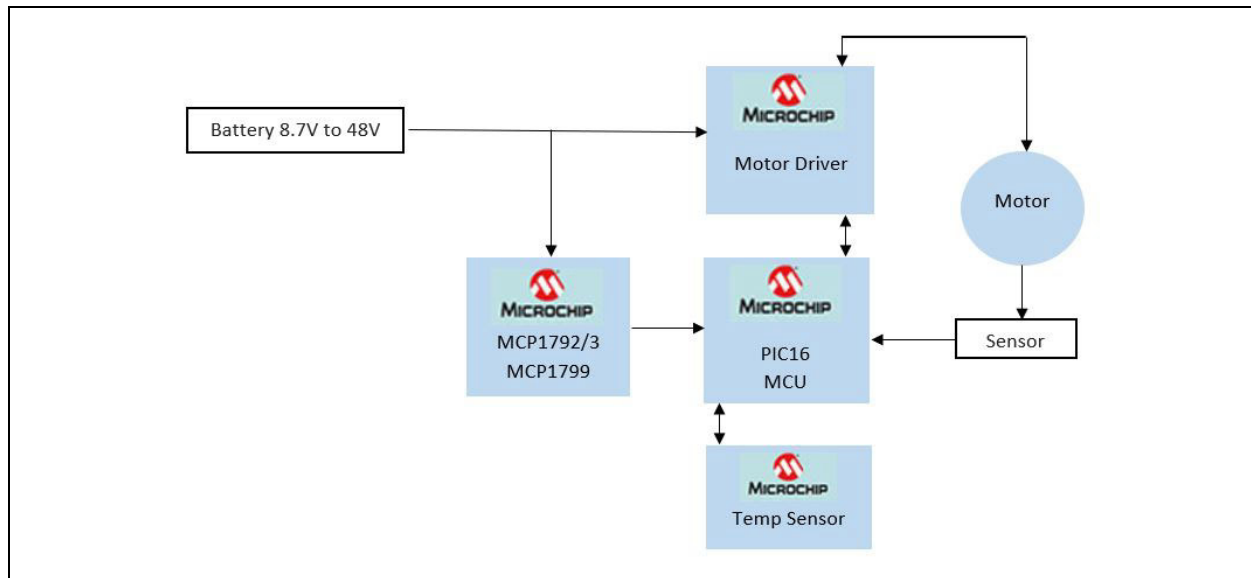


FIGURE 3: Battery-Powered Tools Block Diagram.

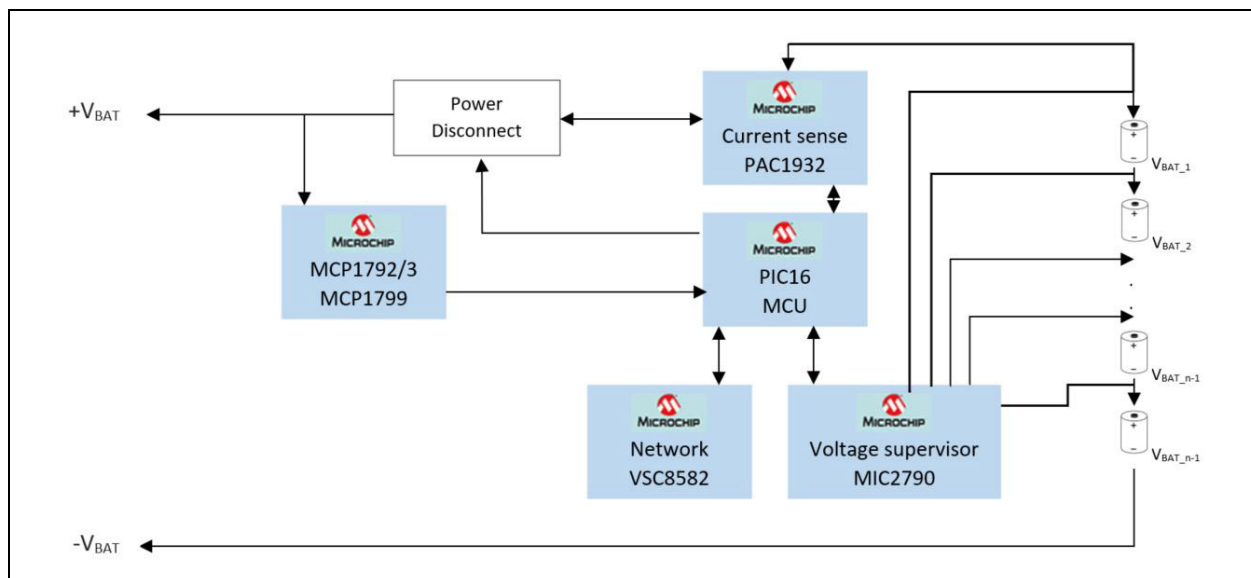


FIGURE 4: Smart Battery Pack Application Block Diagram.

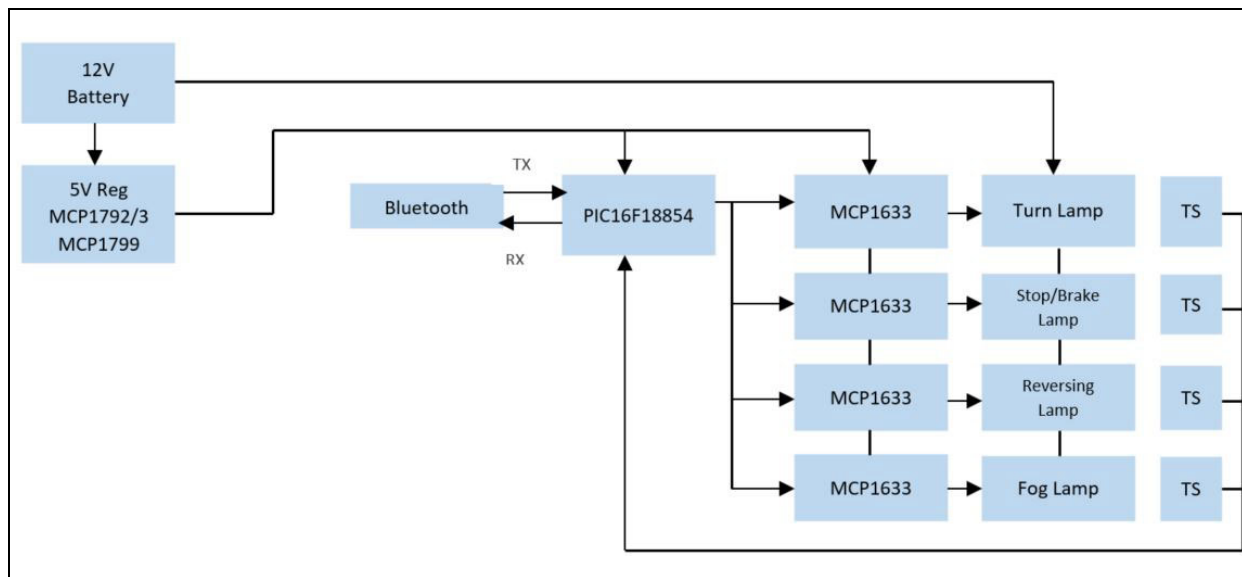


FIGURE 5: Automotive Tail Light Reference Design Block Diagram.

AUTOMOTIVE LDOs

TABLE 1: AUTOMOTIVE MICROCHIP HIGH-VOLTAGE LDOs

Parameters	MCP1790/1	MCP1792/3	MCP1799	MAQ5280/1/2/3	MIC5233
V _{IN} Range [V]	6 to 30	4.5 to 55	4.5 to 45	0: 4.5 to 120 1/2/3: 6 to 120	2.3 to 36
Load [mA]	70	100	80	0/1: 25 2: 50 3: 150	100
Quiescent Current [μA]	70	25	25	0: 31 1/2: 6 3: 8	18 (I _{load} = 100 μA)
Quiescent Current in SHDN [μA]	10	2	—	0: 0.02	0.1
Ground Current [μA]	110	100	45	0: 260 1/2: 6 3: 8	1000
Temperature Range	-40°C to +150°C	-40°C to +150°C	-40°C to +150°C	-40°C to +125°C	-40°C to +125°C
Current Limit Protection [mA]	105	230	150	0: 70 1: 65 2: 125 3: 300	190
PSRR [dB] at 100 Hz	90	80	70	0/2: 80 1: 90 3: 75	60
Other Features	Current Foldback	Current Foldback	Current Limit	Current Limit	Current Limit
Packages and (MSL)	SOT223-3 (1) SOT223-5 (1) DDPAK-3 (1) DDPAK-5 (1)	SOT223-3 (2) SOT223-5 (1) SOT23A-3 (1) SOT23A-3 (1)	SOT23-3 (1) SOT223-3 (2)	0/3: SOIC8 (2) 1/2: MSOP-8 (3)	SOT23-5 (1) SOT223-3 (3)

NOTES:

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