AND8109/D

LED Constant Current Source Scheme

Theory of Operation

Prepared by: Mark Scholten
Senior Applications Engineer

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The LM317L wants to see 1.25 V between its V_{OUT} pin and the V_{adj} pin, and it will do whatever it can to keep that voltage differential between them. So if a resistor is put in series with the output, and the V_{adj} pin is connected to the load side of the sense resistor, a current source is set up which follows Equation 1:

$$I_{OUT} = \frac{1.25}{R_{sense}} \text{ (Approximately)} \quad \text{(eq. 1)}$$

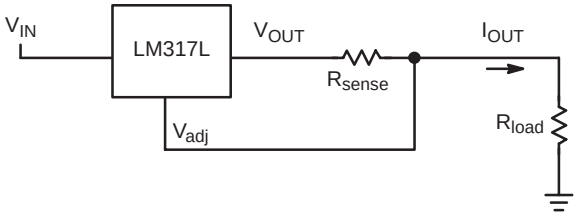

Figure 1.

In order to set up a constant current source for an LED string, the same circuit can be used by simply substituting R_{load} with an LED string, as shown below.

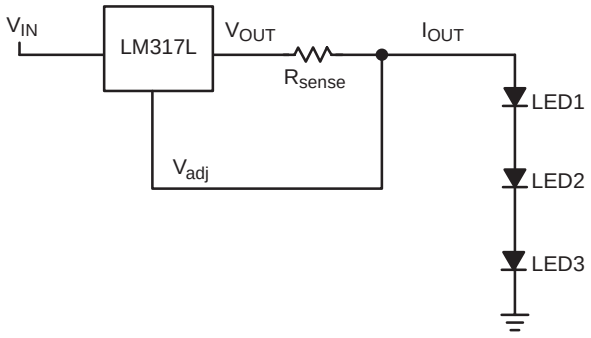

Figure 2.

But what if a series/parallel combination of LEDs is wanted? The following circuit works fine, assuming that there are not large variations in the forward voltage drop of the LEDs. There could be a problem however if one of the strings opens up for some reason. The LEDs that remain would have 50% more current flowing through them, which could cause them to be driven too hard and fail. So how does one get around this problem?

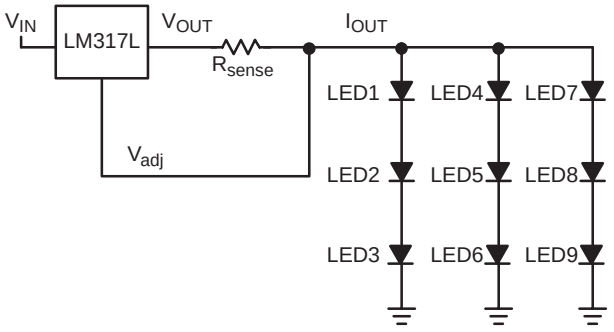

Figure 3.

The following circuit takes care of this issue by splitting up the current sense resistor into three resistors, one for each leg of the LED string. The current through any one of the LED strings is set by Equation 2:

$$I_{OUT} = \frac{1.25\ V + V_{sat}}{R1} \text{ (Approximately)} \quad \text{(eq. 2)}$$

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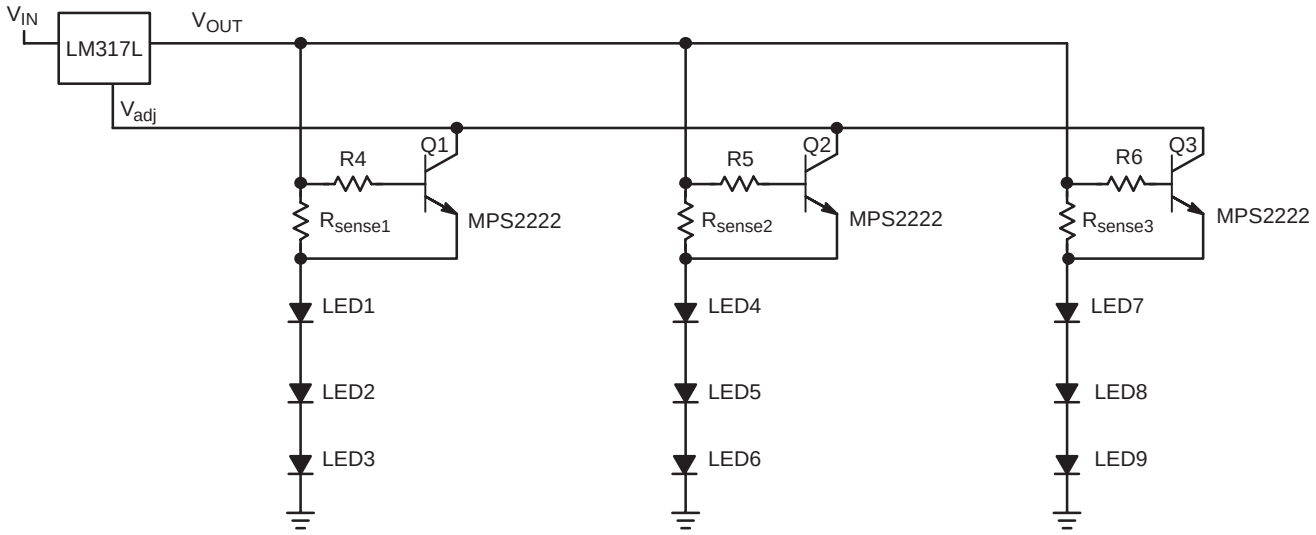

Figure 4.

When the circuit operates properly and all the LEDs are running, the three sense resistors have about 1.25 V across them, which turns the transistor switches ‘on’. This connects all three sense resistors back to the V_{adj} pin allowing the proper current to go through each leg. If one string opens up, the sense resistor for that leg won’t have any voltage across it, turning ‘off’ the transistor and disconnecting its sense resistor from the V_{adj} pin. Therefore, the other two LED strings are unaffected by the fault. This same scheme can be expanded to accommodate as many LED strings as needed.

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