Application Hint 28

0V to 25V Adjustable Regulator

by Jerry Kmetz

An adjustable power supply should provide a range that includes 0V. However, as shown in Figure 1, a typical adjustable regulator does not facilitate adjustment to voltages lower than V_{REF} (the internal bandgap voltage). Feedback-loop summing junction ADJ must be biased at V_{REF} to provide linear operation. The lowest output voltage available from this circuit is provided when R1 = 0Ω. For the MIC29152 LDO Regulator V_{REF} = 1.24V. $V_{OUT} = V_{REF}(1+R1/R2)$.

The circuit of Figure 2 provides adjustability down to 0V by controlling the ground reference of the feedback divider. Moreover, it makes use of the internal bandgap reference to provide both accuracy and economy. Non-inverting amplifier A2 senses V_{REF} (via V_{ADJ}) and provides a gain of just slightly more than unity. When R5 is adjusted to supply ground to voltage follower A1 then ground is also applied to the bottom of feedback voltage divider R1 and R2, and operation is identical to the circuit of Figure 1 (adjusted to provide maximum output voltage). Conversely, when R5 is adjusted so the input to voltage follower A1 is taken directly from the output of amplifier A2 the bottom of voltage divider R1 and R2 is biased such that V_{ADJ} will equal V_{REF} when V_{OUT} is 0V. Rotation of R5 results in a smooth variation of output voltage from 0V to the upper design value, determined by R1 and R2, again: $V_{OUT(max)} = V_{REF}(1+R1/R2)$.

The gain of amplifier A2 is 1+R4/R3 = 1.05, in this example. It is interesting to note that the portion of gain above unity is the reciprocal of the attenuation ratio afforded by feedback divider R1 and R2; i.e., R4/R3 = 1/(R1/R2). To provide optimal ratio matching, resistors R3 and R4 have been chosen to be the same values and types as their counterparts R1 and R2, respectively.

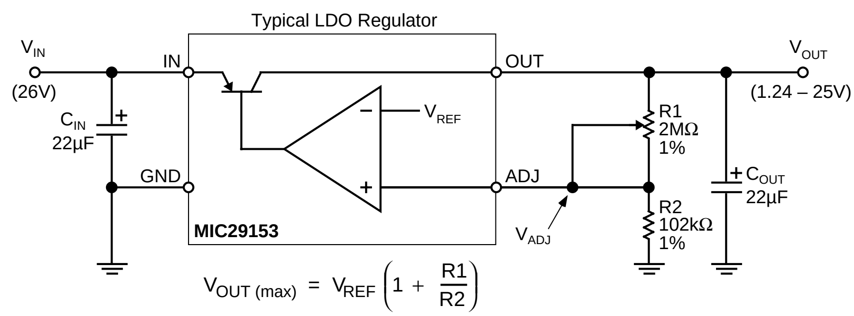

Figure 1. Typical Adjustable Regulator

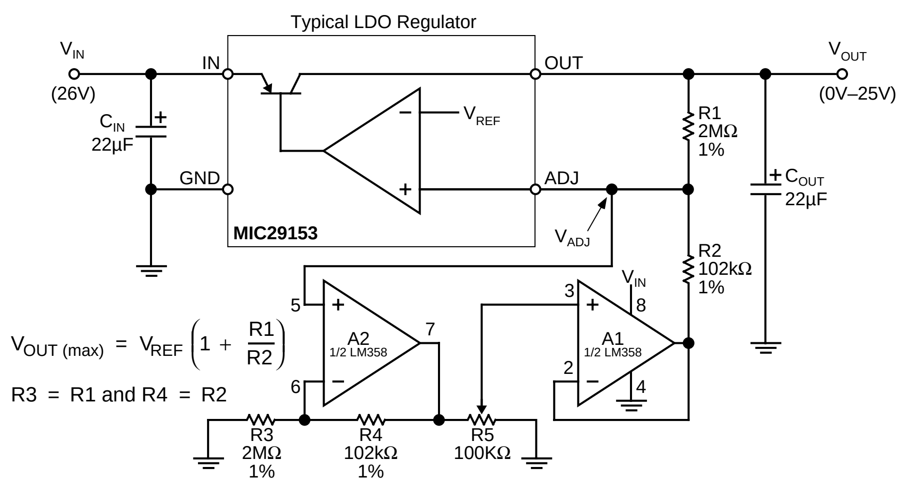

Figure 2. 0V–25V Adjustable Regulator