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Keywords: external transister, linear voltage regulator, low dropout voltage, long battery life

APPLICATION NOTE 1853

External Pass Transistor Lowers Dropout Voltage

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For linear regulators, dropout voltage (V_{IN} - V_{OUT}) is measured at the minimum input voltage for which regulation is sustained. Low dropout means longer battery life, because the load circuit continues to operate while the battery discharges to a lower terminal voltage. In **Figure 1** the external transistor shown helps to form a linear-regulator circuit whose dropout at 100mA load current is only 10mV. (The low-dropout linear-regulator IC by itself has a 100mV dropout at that load current.) The external transistor also boosts the maximum available load current to 1A.

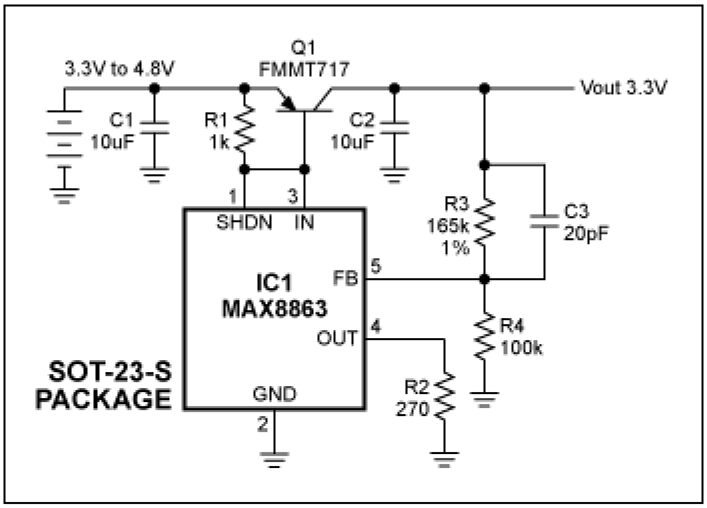

Figure 1. Unusual connections enable this linear-regulator IC to regulate the transistor's base current, forming an overall linear regulator with much lower dropout voltage.

Unorthodox connections enable the IC to drive Q1. Connecting pin 3 to the transistor's base allows base current to flow through the internal switching MOSFET, out of pin 4, and through R2 to ground. The MOSFET then regulates V_{OUT} by controlling Q1's base current. Because C2 sets a dominant pole that stabilizes the loop, it should be a ceramic type or other low-ESR capacitor. C2 improves the phase margin by forming a pole-zero combination that increases the phase at crossover.

Q1 saturates when the battery voltage drops low enough for V_{OUT} to drop out of regulation, and R2 limits the base current for that condition to approximately 10mA. Q1's collector-emitter voltage at saturation, which measures 10mV with 10mA base current and 100mA collector current, sets the dropout voltage for these conditions. The measured dropout voltage varies with load current (**Figure 2**).

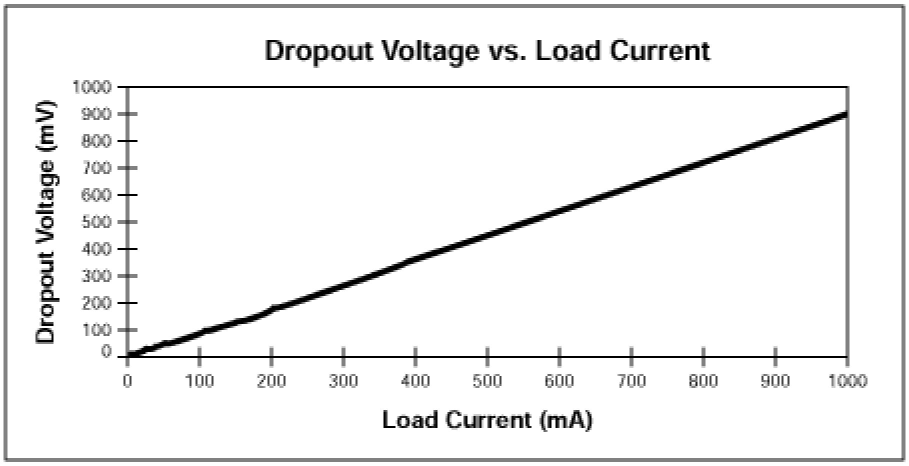

Figure 2. Dropout voltage for the Figure 1 circuit varies (almost) linearly with load current.

This circuit delivers as much as 1A at 3.3V. You can adjust the output from 5.5V down to 1.25V using the formula $V_{OUT} = 1.25[1 + (R3 / R4)]$, with appropriate changes to the value of R2 using the formula $R2 = (V_{IN(MIN)} - 0.7V) / 10mA$. Small component sizes (IC1 fits in a SOT23 package) allow the entire circuit to occupy less than 0.24 in² of board area.

Related Parts		
MAX8863	Low-Dropout, 120mA Linear Regulators	Free Samples

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