Network linearizes dc/dc converter's current-limit characteristics

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Recently announced versions of integrated step-down dc/dc converters have eliminated the requirement for a high-side current-sense resistor by sampling the voltage drop across an external, low-side, MOSFET synchronous rectifier. This topology eliminates the sense resistor's cost and pc-board-space requirement and also provides a modest increase in circuit efficiency. However, the MOSFET's highly temperature-dependent on-resistance dominates the current-limit value. Fortunately, certain newer dc/dc converters, such as Maxim's MAX1714, allow external adjustment of the current-limit threshold. The circuit in **Figure 1** shows how a thermistor applies temperature compensation to the circuit's output-current limit.

The MAX1714's linear current-limit (I_{LIM}) input range at Pin 6 of IC_1 spans 0.5 to 2V, which corresponds to current-limit thresholds of 50 to 200 mV, respectively. For the default current-limit setting, 100 mV, the circuit imposes a 7.5A current limit at 25°C. However, **Figure 2** shows that the current limit varies from 9A at −40°C to 6A at 85°C. To design the temperature-compensation network, begin by breadboarding the circuit and using an

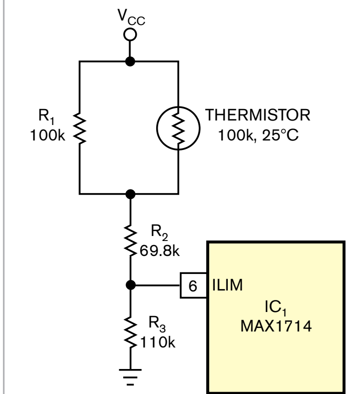

Figure 1 A thermistor-resistor network provides temperature compensation for a dc/dc converter's current-limit input, I_{LIM}.

external power supply to vary the MAX1714's current-limit input voltage such that the output-current-limit value remains constant. You repeat the measurements at 10°C intervals over the circuit's operating-temperature range.

To compensate for IC_1's temperature variation, you can select from among several possible resistor-thermistor-network topologies. First, you need to select a suitable thermistor and characterize its resistance-versus-temperature variation. Because the MAX1714's current-limit input pin feeds a relatively high input-impedance voltage-follower stage, this thermistor requires a high nominal resistance of 100 kΩ. Resistance-versus-temperature characteristics of inexpensive thermistors exhibit considerable nonlinearity, but one relatively simple approach to linearization involves paralleling the thermistor with a fixed resistor equal to the thermistor's nominal resistance (**Reference 1**). In the network of **Figure 1**, R_1 linearizes the thermistor, and R_2 and R_3, respectively, set the slope and intercept of the current-limit-voltage-versus-temperature-characteristic curve.

To arrive at optimal values for R_2 and R_3, we prepared a spreadsheet incorporating the original current-limit-voltage-versus-temperature data and added columns for each of the network's resistors, plus the thermistor specification sheet's resistance-versus-temperature data. While observing the circuit's temperature-versus-voltage transfer function, we varied the spreadsheet's values for R_2 and R_3 until the transfer function best approximated the measured current-limit-voltage-versus-temperature data. Finally, we constructed the circuit and tested it over the temperature range and noted that it yielded a reasonably flat response.

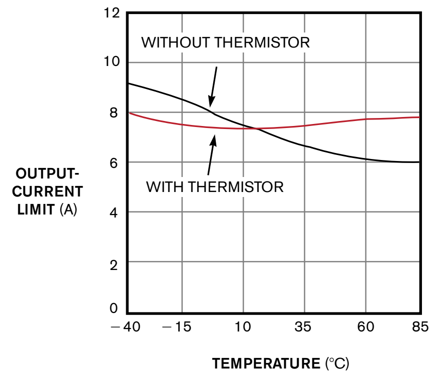

Figure 2 Before (black trace) and after (red trace) current-limit-versus-temperature characteristics show the performance enhancement that the circuit in Figure 1 provides.

The curvature of the corrected output characteristic of **Figure 2** (red trace) is intrinsic to the thermistor. Though not perfectly flat, the corrected curve represents a great improvement over the original (black trace) and is sufficient to meet the original design goal. You can achieve more precise compensation by selecting a different thermistor or by incorporating multiple thermistors. EDN

REFERENCE

1 Horowitz, Paul and Winfield Hill, *The Art of Electronics*, ISBN 0 521 37095 7, Cambridge University Press, New York, 1980.