Keywords: shunt regulator, current limit, power amplifier, adjustable shunt regulator

APPLICATION NOTE 3867

# Shunt Regulator Improves PA's Current-Limit Accuracy

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*Abstract: Substituting a shunt regulator (U1) for the usual transistor in this power-amplifier circuit improves the current-limit accuracy.*

Adding current-limiting circuitry to an emitter follower protects both the pass transistor and downstream circuitry from excessive current damage. The classic way to implement such current limiting is to add a ballast resistor between the pass transistor's emitter and the circuit output, and then monitor the resistor drop with a small-signal transistor. See R4 and Q2 in the power amplifier (or linear regulator) shown in **Figure 1**.

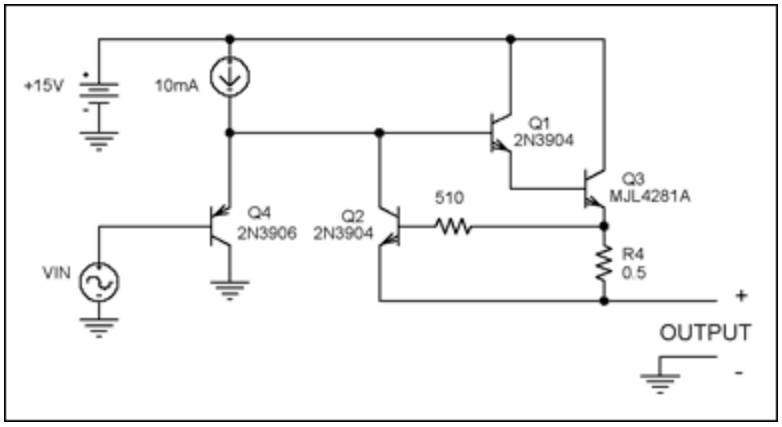


*Figure 1. A small-signal transistor (Q2) provides an output current limit for this power amplifier.*

Unfortunately, the base-emitter voltage of the small-signal transistor sets the current-limit threshold for this circuit. That $V_{BE}$ has a well-known temperature coefficient of -2mV/°C, which causes a substantial change in current limit across the operating temperature range.

An adjustable shunt regulator (U1 in **Figure 2**) is preferable to the small-signal transistor for sensing current. This IC is chosen for its low-input threshold (0.6V), which is lower than that of common shunt regulators (1.25V to 2.5V). In addition, the IC's separate power-supply input allows it to maintain accuracy as the internal output transistor approaches saturation.

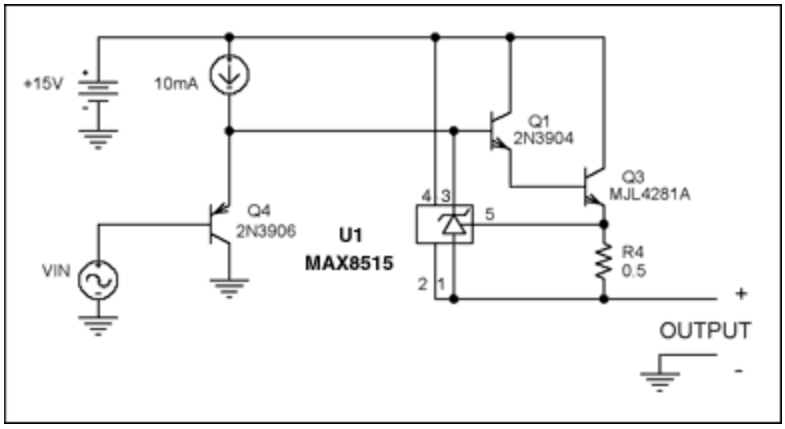


*Figure 2. Substituting a shunt regulator (U1) for Q2 in the Figure 1 circuit improves the current-limit accuracy.*

**Figure 3** compares current-limit accuracies of the small-signal-transistor version of Figure 1 with the shunt-regulator version of Figure 2. The transistor version exhibits a 25% change in current-limit threshold over the operating temperature range, while the shunt-regulator provides better than 2% accuracy over that range (neglecting the temperature coefficients of the sense resistors).

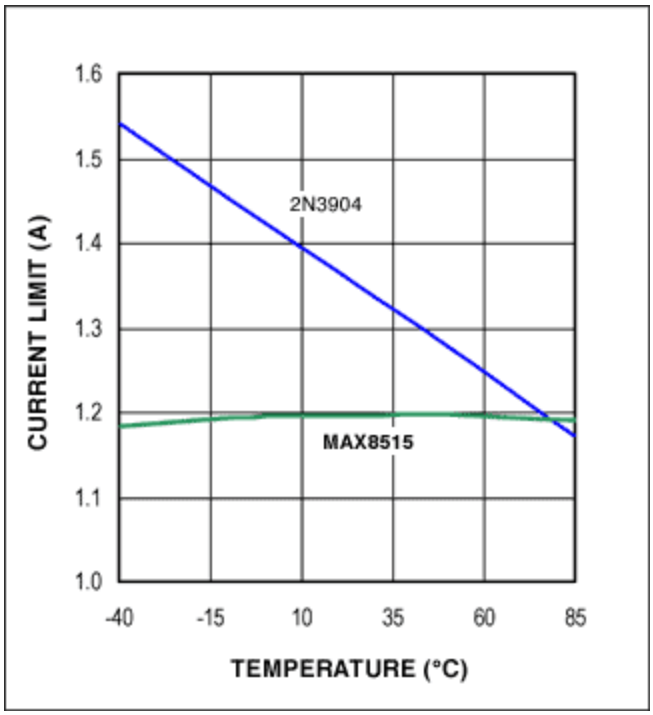


*Figure 3. Current-limit accuracy versus temperature for the circuits of Figure 1 (top trace) and Figure 2 (bottom trace).*

A similar article appeared as a Design Idea in the February 2, 2006 edition of *EDN*.

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