Current mirror improves PWM regulator's performance

Grant Smith, National Semiconductor, Phoenix, AZ

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Power-supply designs requiring high-performance isolated feedback often use an error amplifier similar to the one in **Figure 1**, which relies on a second amplifier, IC_{1B}, to provide the necessary inversion to keep the optocoupler, IC_2, referenced to ground. To prevent bias-supply noise from entering the feedback path and causing oscillations, the amplifier relies on its ground reference and power-supply-rejection characteristics. The power supply's output drives a voltage divider comprising R_1 and R_2 that maintains the amplifier's inverting input at the same voltage as the reference voltage that IC_3 provides. C_2, R_3, and C_3 comprise frequency-compensation components for the power supply's stable operation. This component-intensive error-amplifier configuration requires two operational amplifiers, one precision shunt-voltage reference, four capacitors and often a fifth in parallel with R_6, and seven resistors.

Figure 2 shows an alternative single-amplifier design in which IC_3, an LM4040 precision-voltage reference, drives optocoupler IC_2 with a "stiff" positive-voltage source over a wide current range. The voltage reference suppresses any noise present on the bias-supply rail. Variations in the reference and power-supply voltages appear in common mode at the amplifier's inputs and thus provide additional noise immunity. A resistive-voltage divider comprising R_2 and R_3 reduces the reference voltage to equal the power supply's regulated output voltage, which drives IC_1's inverting input through R_1. Given its single voltage divider, the error-amplifier circuit of **Figure 2** provides the same output voltage as the circuit of **Figure 1** and requires a single operational amplifier and precision shunt reference, four capacitors, and six resistors.

Miller-effect coupling of collector-emitter-voltage transitions into a typical phototransistor-based optocoupler's high-impedance, optically sensitive

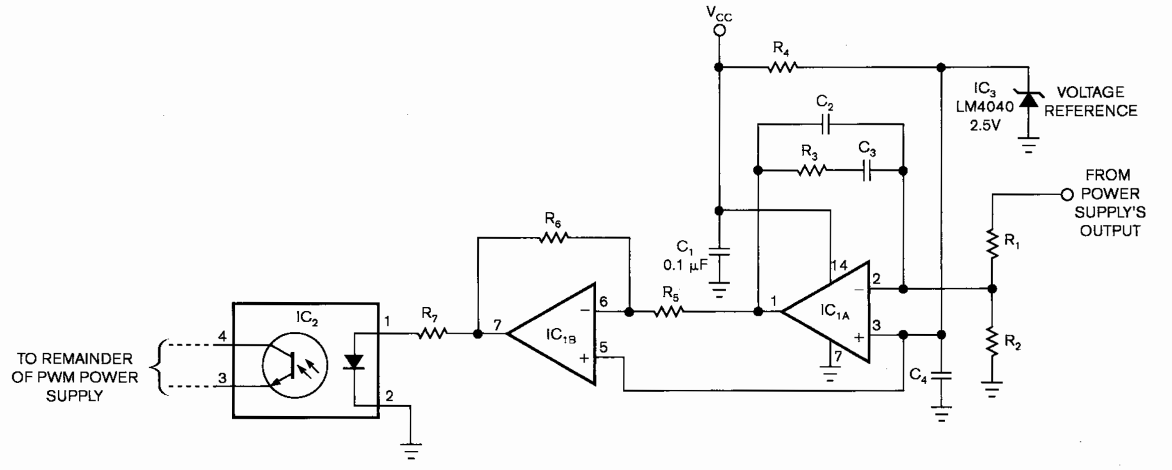

Figure 1 A conventional isolated-feedback circuit requires an extra operational amplifier and adds several passive components to a representative pulse-width-modulated power-supply design.

base region introduces a bandwidth-limiting pole, which dramatically slows the device's response time. Holding the phototransistor's collector-emitter voltage constant and allowing only its collector-emitter current to change provide an order-of-magnitude switching-speed improvement.

National Semiconductor's (www.national.com) LM5026 active-clamp current-mode PWM controller, IC_4, provides a convenient method of reducing an optocoupler's Miller-effect-induced slowdown. **Figure 2** shows the LM5026's internal current mirror driving what would normally serve as a frequency-compensation pin. Optocoupler IC_2 connects directly between two constant-voltage sources comprising the current mirror and a voltage reference. The resultant decrease in response time relocates the bandwidth-limiting pole and improves the circuit's transient response.

The values of C_2, C_3, R_3, and R_1 apply only to this design and may require modification for other applications. Select R_1 to provide equal impedances at both of the op amp's inputs. C_2 forms a high-frequency noise filter. After you measure the converter's overall gain, calculate values for C_3 and R_3 that will provide proper gain and phase response. Several methods of calculation are available, most of which will provide adequate results. EDN

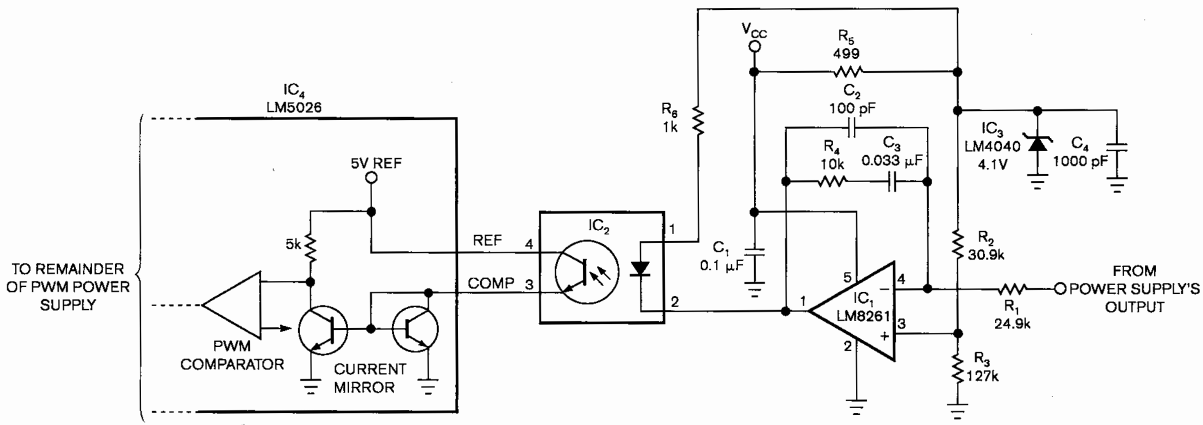

Figure 2 Clamping an optoisolator's voltage excursion improves the PWM-regulator loop's transient response.