Line-powered driver lights up high-power LEDs

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Using LEDs has gained popularity as a method of saving power for general-purpose lighting, but an efficient method for driving them has also become a necessity. For example, Lumileds' (www.lumileds.com) Luxeon devices create lighting effects or room lighting. Providing power to a few LEDs may require only a current-limiting resistor, but illumination applications need a string of 20 or more LEDs to provide light over an area. Based on On Semiconductor's (www.onsemi.com) NCP1200A, a 100-kHz PWM current-mode controller for universal offline power supplies, the circuit in **Figure 1** provides a low-cost, offline constant-current source for powering multiple LEDs. Although designers typically configure it to provide a voltage source, in this application, the NCP1200A provides a constant-current source. **Figures 2** and **3** show close-ups of the circuit.

A full-wave bridge rectifier, D_2 to D_5, and filter capacitor C_1 provide approximately 160V dc to the conversion circuit, IC_1, and its associated components. Resistor R_3 alters the bias for IC_1's current-sense pin and, at 6.2 kΩ, allows the use of a 1.2Ω sense resistor for R_6. Decreasing R_6 not only reduces costs over a higher wattage sense resistor, but also improves the circuit's efficiency. Capacitor C_3 stabilizes the feedback network's current and carries a 400V rating in case of an open circuit in the LED string. An RC network comprising R_5 and C_4 provides a small amount of lowpass filtering to the CS pin.

Bleeder resistors R_1 and R_2 eliminate any shock hazard across the ac-line plug's prongs when you disconnect it. Although you can use a 1-MΩ through-hole-mounted resistor, two surface-mounted 500-kΩ series resistors cost less and provide the required track-

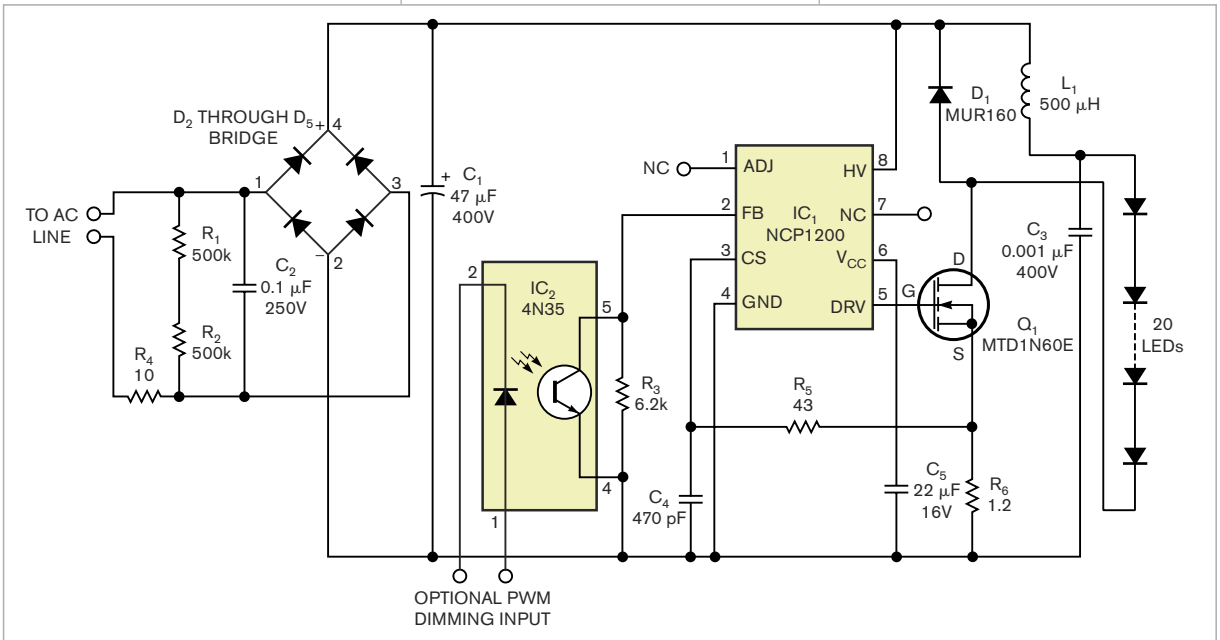

Figure 1 An offline constant-current source drives a string of high-output LEDs.

to-track pc-board spacing for line-voltage applications. Use a capacitor rated for line-bypass service for capacitor C_2. You can use any power MOSFET with a suitable breakdown voltage and a low on-resistance, such as an MTD1N60E or IRF820, for Q_1. Inductor L_1, a 500-µH device, should be able to operate at 100 kHz and handle more than 350 mA of continuous current. You can use an inductor from Coilcraft's (www.coilcraft.com) RFB1010 or DR0810 series of surface-mount inductors, or you can experiment with inductors manually wound on suitable core materials. As an option, adding optoisolator IC_2 allows microcomputer-controlled illumination dimming using pulse-width modulation of IC_1's feedback terminal, Pin 2.

To understand the economic motivation for using LEDs as illuminators, compare the light output of a string of 20 1W, white Luxeon emitters with a standard incandescent light bulb. Each LED provides 45 lumens, or 900 lumens for a string of 20 LEDs. The average forward voltage per LED is 3.42V for a power dissipation of 1.197W each at a forward current of 350 mA. Thus, the 20-LED string dissipates 23.94W. Factoring in a conservative 80% efficiency for the power supply, the power the system consumes becomes 28.73W for a light-emission-efficiency value of 900 lumens/29W or 31 lumens/W. The Luxeon emitters also carry a rating for 100,000 hours, or approximately 11 years, of operation.

In contrast, a standard 60W Philips incandescent light bulb produces 860 lumens for 1000 hours, or just over a month, at an efficiency of only 14 lumens/W. From a power-consumption viewpoint, the LED-based design is twice as efficient as the incandescent-bulb-based design and thus reduces power consumption and cost. In addition, the LED design imposes no additional maintenance costs for replacement bulbs and labor. EDN

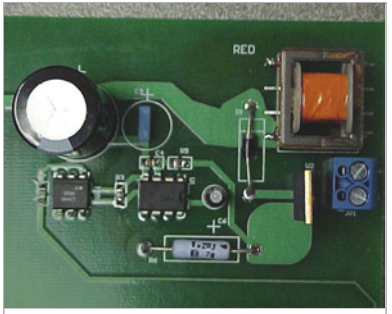

Figure 2 A close-up view of the circuit of Figure 1 shows inductor L_1 in the upper right corner.

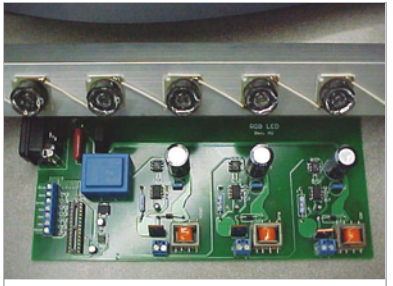

Figure 3 This version of the circuit comprises three constant-current driver channels. An LED light-bar assembly is above the pc board.