DI-92 Design Idea
LinkSwitch®-TN

0.5 W Non-Isolated Constant Current LED Driver

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
LED Driver	LNK302PN	0.5 W	85 – 265 VAC	40 mA	Buck-Boost

Design Highlights

- Extremely low component count – only 9 components required
- Universal AC input range – single design worldwide
- Low cost, small size and very lightweight
- Replacement for passive capacitor or resistor droppers
- High efficiency (approximately 70% at 85 VAC)
- Meets EN55022 B EMI limits with >8 dB margin (see Figure 2)

Operation

Figure 1 shows a simple buck-boost converter, operating in open loop with no output feedback, being used as a constant current LED driver. The circuit relies on the internal current limiting function of the LNK302PN, which ensures constant current is supplied to the load. Typical uses include night-lights, neon sign replacements, emergency exit signs or any application utilizing LEDs for lighting.

The AC input is rectified and filtered by D1, C1, C2, and RF2. For safety, resistor RF1 should be a fusible flameproof type, whereas RF2 can be flameproof only.

LinkSwitch-TN uses current limited ON/OFF control to regulate the output current. This type of control inherently rejects any input voltage variations over the entire operating range. Current greater than 49 µA into the FEEDBACK pin disables the MOSFET for that switching cycle. Since there is never any current being fed back into the FEEDBACK pin in this application, the device will switch and ramp up to the current limit for each and every cycle.

Since the peak current is limited and fixed for each cycle, the output power is solely determined by the size of the inductor. It is recommended that this design operate in the discontinuous conduction mode (DCM). Besides better EMI performance, this also ensures that a low cost 75 ns reverse recovery diode such as the UF4005 can be used. For designs that operate in the continuous conduction mode (CCM), a more expensive but faster diode (30 ns reverse recovery) like the BYV26C may be required.

The output will be replenished every switching cycle (66 kHz), and thus the need for the output filter capacitor is eliminated. Persistence of vision of the human eye (typically 10 ms) is much longer than the switching period, and it thus sees a consistent light output without flicker.

Select the value of L1 following the LinkSwitch-TN Design Guide (www.powerint.com/appnotes.htm), or using the PI Xls design spreadsheet (www.powerint.com/designsoftware.htm). Enter the output voltage as the voltage of the LED string, and the output current as the total combined LED current. Alternately, one can calculate the inductance using

$$P_O = \frac{1}{2} \cdot L \cdot {I_{LIMIT}}^2 \cdot f_S \cdot \eta$$

$$\Rightarrow L = \frac{2 \cdot P_O}{{I_{LIMIT}}^2 \cdot f_S \cdot \eta}$$

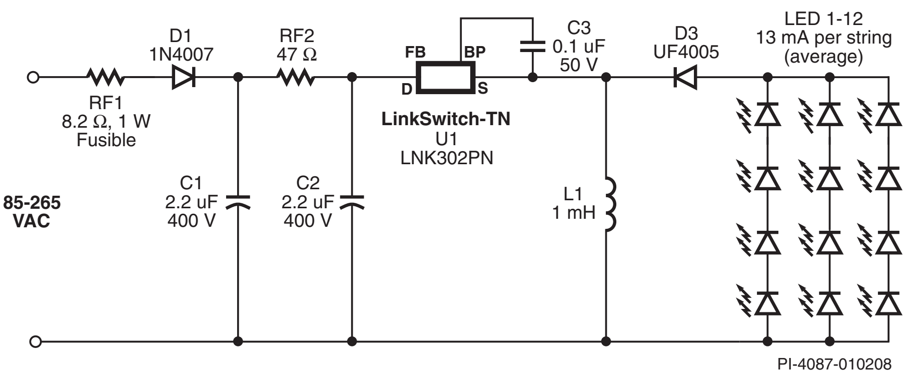

Figure 1. A 0.5 W, 12.9 V, 40 mA Constant Current LED Driver, Using a Non-Isolated Buck-Boost Topology.

Key Design Points

- The circuit shown in Figure 1 has a total output current tolerance of ±12% (including ΔT of 50 °C).
- To prevent noise coupling to the input, place the input filter components physically away from the source node of the LinkSwitch-TN and L1 inductor. The DC input filter capacitors C1 and C2 can be placed as a barrier between the AC input and these two components.
- The circuit shown in Figure 1 uses a low cost resistive pi (π) filter for differential mode filtering. For output power greater than 0.5 W, an inductive pi filter is recommended.
- For better EMI performance, operate the circuit strictly in DCM (see Figure 3 – output current decays to zero in every switching cycle).
- A second rectifier diode may be placed in the return leg of the AC input (not used in Figure 1). This may give improved EMI performance and better surge withstand capability.
- The maximum number of LED strings determines the total output current and is limited by the current limit of the LNK302PN device and the inductance of L2.

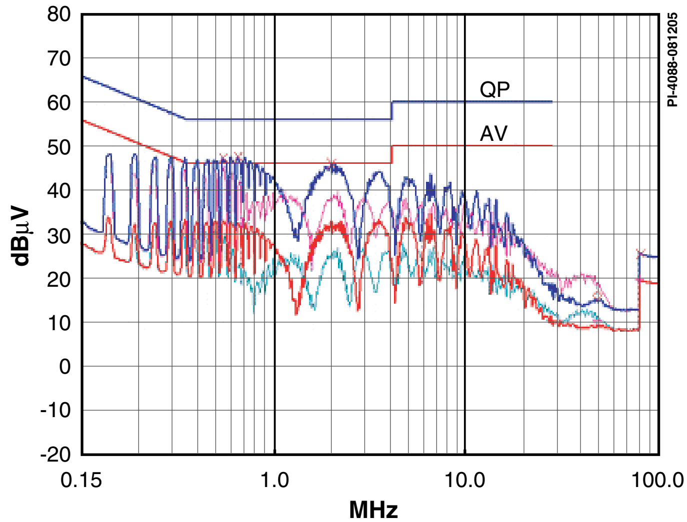

Figure 2. Conducted EMI Plot of the Schematic Shown in Figure 1 – Background Scans Taken at 110 VAC: Foreground Scans Taken at 230 VAC.

Populated Circuit Board.

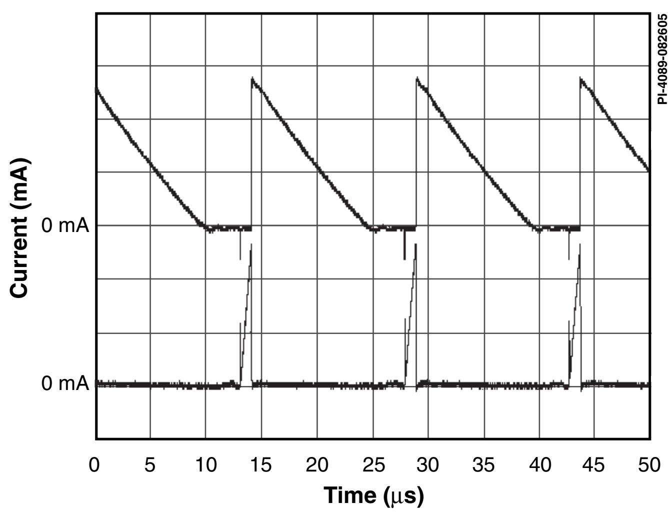

Figure 3. Output Current (Top Trace) and Input Current (Bottom Trace), 50 mA/div, 5 µs/div.

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