DI-172 Design Idea
LinkSwitch®-TN

High Efficiency Constant Current Buck Converter for LED Lighting

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
LED Lighting	LNK306PN	9.1 W	108 – 132 VAC	70 V	Buck

Design Highlights

- Constant current output (±10%) is ideal for driving LEDs
- High output voltage allows a single LED string – eliminates need to consider current sharing between LEDs
- Protected against disconnected load, overload, short circuit and over temperature
- Very high efficiency (>90%) throughout operating range (see Figure 2)
- Compact, lightweight, inexpensive, low part count design
- No transformer needed – simple single inductor design
- Meets EN55022B limits for conducted EMI with greater than 10 dBμV margin (see Figure 3)

Operation

The power supply shown in Figure 1 uses a LinkSwitch-TN device in a low side buck converter configuration to deliver a constant current of 130 mA at a voltage of 70 VDC. The supply provides an ideal solution for driving LEDs that should be driven with a constant current rather than a constant voltage source.

Fuse F1 provides catastrophic failure protection. Capacitor C1 and common mode choke L1 reduce conducted EMI. Diodes D1 through D4 provide full wave rectification while high voltage capacitor C2 maintains a steady DC bus voltage.

During U1's on time, current flows through capacitor C4, the load (70 V LED string) and inductor L2. This current flow results in energy storage in L2 and energy delivery to the load.

During U1's off time, the polarity of L2 reverses in an attempt to maintain the current flow. This polarity reversal forward biases the freewheeling diode D5, which allows current to flow and energy continues to be delivered to C4 and the load.

Output regulation is maintained by an On/Off control scheme whereby switching cycles are enabled and disabled (skipped) in response to changing line and load conditions. The feedback (FB) pin of U1 is sampled at the beginning of each cycle. If current in excess of 49 μA is delivered into the FB pin by the transistor of optocoupler U2, the current cycle is skipped. Capacitor C3 is the bypass capacitor for the LinkSwitch-TN device.

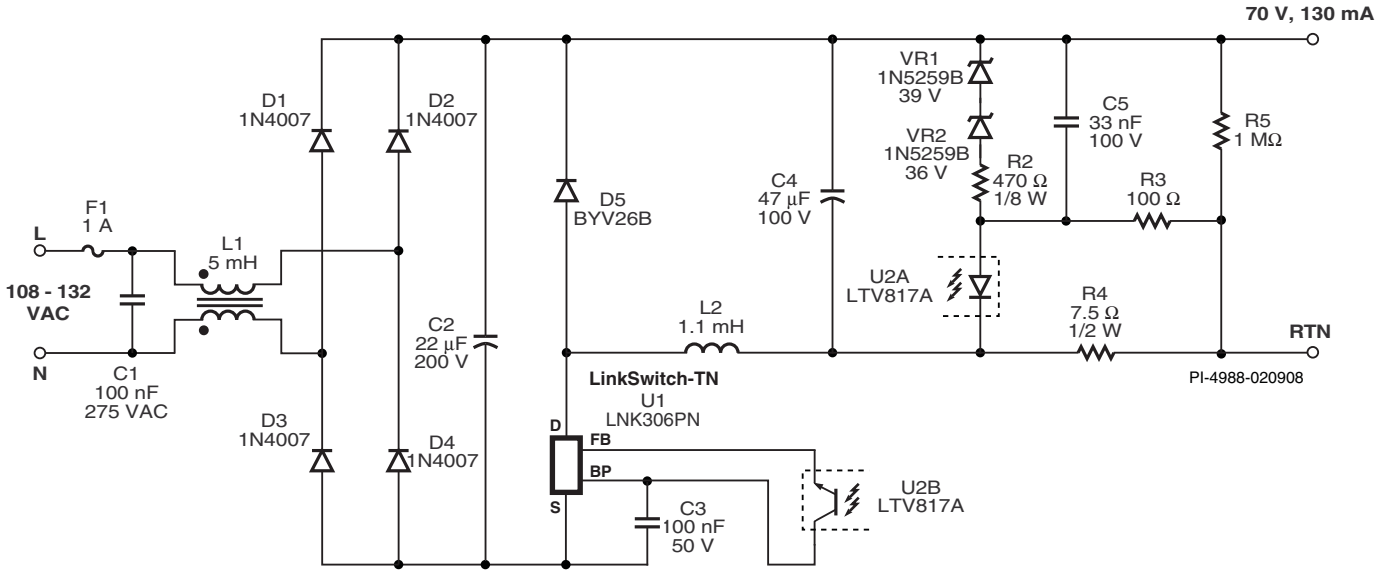

Figure 1. Schematic of a 70 V, 9.1 W Constant Current Buck Converter for Driving LED

Resistor R4 acts as a current sensing resistor. Once the voltage across R4 exceeds the V_F of the opto LED, the feedback loop closes, and the output current is regulated. Resistor R3 sets the DC gain of the feedback loop. If the load is disconnected, the output voltage is regulated to a maximum of approximately 75 V by Zener diodes VR1 and VR2. Capacitor C5 is used to reduce noise sensitivity and to help evenly distribute the switching cycles. Optional resistor R5 bleeds the high voltage output capacitor when power is removed.

Key Design Points

- Select diode D5 to be an ultrafast type with a reverse recovery time (trr) of 50 ns or less. Although a slower diode like the UF4005 (trr = 75 ns) may be used, it may cause larger current spikes at turn on and result in reduced efficiency.
- Use of an optocoupler to derive feedback allows the placement of U1 on the low side of the DC bus. Due to the source connected tab of U1, this also results in reduced EMI.
- Zeners VR1 and VR2 may be removed if the supply will always operate with a load connected.
- Select the LED string such that the voltage is in the range of 50 V – 70 V.

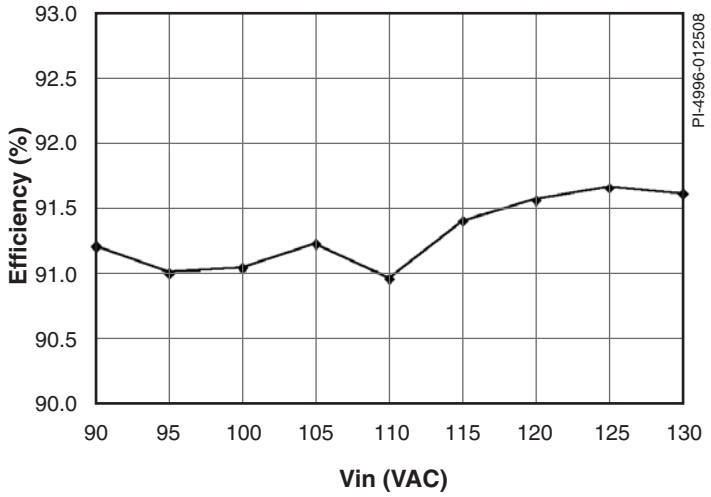

Figure 2. Line Voltage (VAC) vs. Efficiency (%).

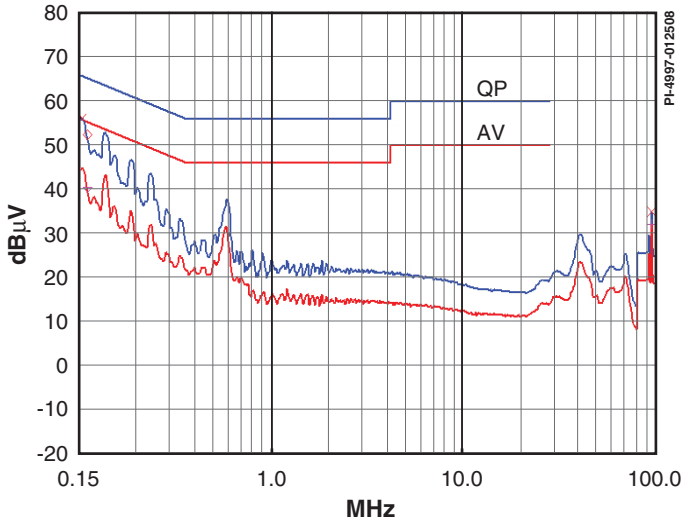

Figure 3. Worst Case EMI Plot, 115 VAC, LED Load at 70 V, 135 mA, EN55022B Limits.

Inductor Parameters	
Core Material	TDK PC40EE or equivalent, gapped for ALG of 107.8 nH/t²
Bobbin	EE19 Vertical 10 pin or equivalent
Winding Details	101 Turns of AWG 27 solderable double coated wire.
Inductance	1.1 mH ±10%

Table 1. Transformer Parameters.

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