DI-206 Design Idea
LinkSwitch®-II

3.67 W LED Driver

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
LED Driver	LNK605DG	3.67 W	90 – 265 VAC	10.5 V	Flyback

Design Highlights

- Fits inside an extended GU-10 lamp base
- Accurate primary-side constant voltage/constant current (CV/CC) controller eliminates secondary-side control and optocoupler
  - No current-sense resistors, for maximized efficiency
  - Low part-count solution for lower cost
- Over-temperature protection – tight tolerance (±5%) with hysteretic recovery for safe PCB temperatures under all conditions
- Auto-restart output short circuit and open-loop protection
- Highly energy efficient
  - Full load efficiency >74% throughout operating range
  - No-load consumption <200 mW at 265 VAC
- Ultra-low leakage current: <5 µA at 265 VAC input (no Y capacitor required)
- Green package: halogen free and RoHS compliant

Operation

Figure 1 provides the schematic for a universal input, 10.5 V, 350 mA CV/CC power supply using the LinkSwitch-II LNK605DG (U1) in a flyback configuration, useful for LED driver applications. The design is intended to drive a 3 LED series string, delivering the rated output current over the range of LED V_F.

Integrated circuit U1 consists of a power switching device, an oscillator, a CV/CC control engine, startup and protection functions. The primary side CV/CC control functionality of U1 eliminates the need for sense resistors and optocouplers, which results in an ultra-compact footprint for this design which can mechanically fit inside a GU-10 LED enclosure.

Bridge BR1 rectifies the AC input voltage. The rectified DC is filtered by the bulk storage capacitors C1 and C3. Inductor L1, along with capacitors C1 and C3, form a pi (π) filter which attenuates conducted differential-mode EMI noise. This configuration, along with Power Integrations' transformer E-Shield™ technology, allows this design to meet EMI standard EN55015 class B with 6 dB of margin, without using a Y capacitor. Fusible, flameproof resistor RF1 limits inrush current when AC is applied and during differential mode line surge.

One side of T1's primary winding receives the rectified, filtered DC voltage. The MOSFET drives the other side of the primary. The RCD-R clamp formed by D2, R4, R5, and C4 limits any drain-voltage spikes caused by leakage inductance.

Device U1 is completely self-powered from the BYPASS (BP) pin and decoupling capacitor C2. It regulates the output using ON/OFF control for constant voltage (CV) regulation, and frequency control for constant current (CC) regulation. Feedback resistors R1 and R2 have 1% tolerance values to accurately center both the nominal output voltage and the current in CC operation. The CV feature also provides output over-voltage protection (OVP) in case any LEDs fail open-circuit.

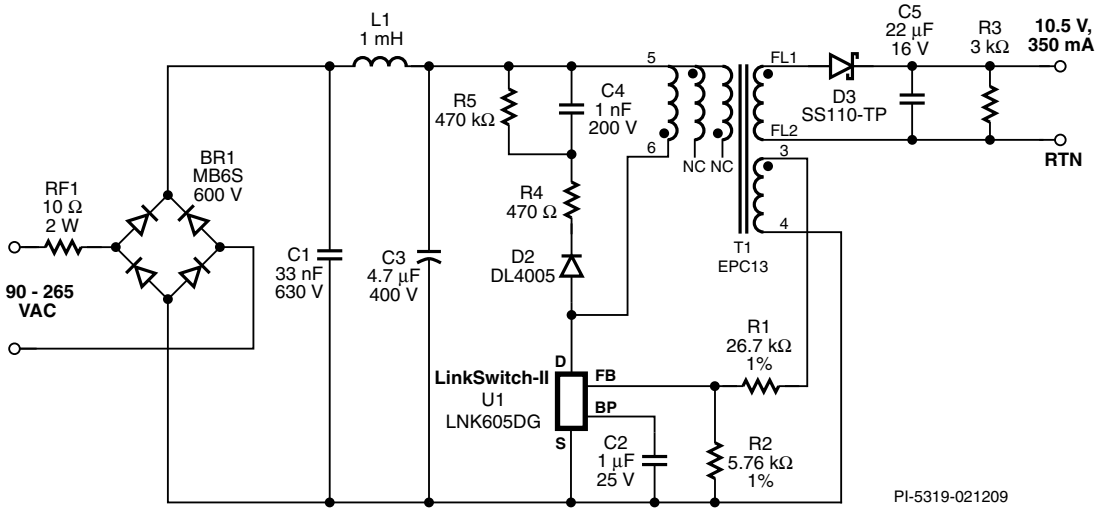

Figure 1. 10.5 V, 350 mA LED Driver Circuit Using Primary Side Control IC LNK605DG.

Traversing from no load to full load, the controller within U1 first operates in the CV region. Upon detecting the maximum power point, the controller goes into CC mode.

In the CV region U1 maintains the output voltage level by skipping switching cycles, maintaining regulation by adjusting the ratio of enabled cycles to disabled cycles. The current limit is also lowered in order to reduce audible noise at low load to imperceptible levels. As the load increases, current limit also increases and fewer and fewer switching cycles are skipped to deliver more output power.

When U1 enters a state where no switching cycles are skipped (concurrent with the maximum power point) the controller within U1 transitions into the CC mode. A further increase in the demand for load current causes the output voltage to drop. This drop in output voltage is reflected on the FB pin voltage. In response to this voltage reduction at the FB pin, the switching frequency is reduced to achieve constant output current.

The transformer's secondary is rectified by D3, a Schottky-barrier diode (chosen for higher efficiency), and filtered by C5. In this application by design C5 has a low ESR, which enables the circuit to meet the required output voltage ripple requirement without using an LC-post filter.

Key Design Points

- The IC package provides extended creepage distance between high and low voltage pins (at both the package and the PCB), required in very humid or polluted environments to prevent arcing and to further improve reliability.
- Place C2 as close to the BYPASS pin as possible.
- Feedback resistors R1 and R2 have 1% tolerance values to assist in centering both the nominal output voltage and the CC regulation threshold tightly.
- An optional bias winding can be added to lower no-load power consumption.

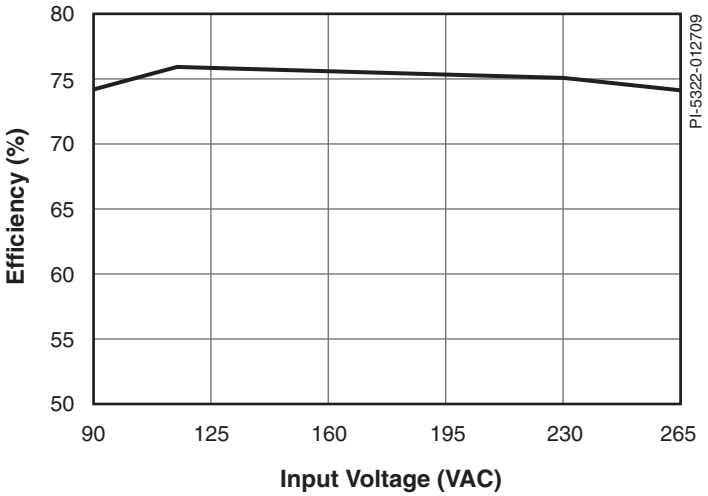

Figure 2. Full Load Efficiency.

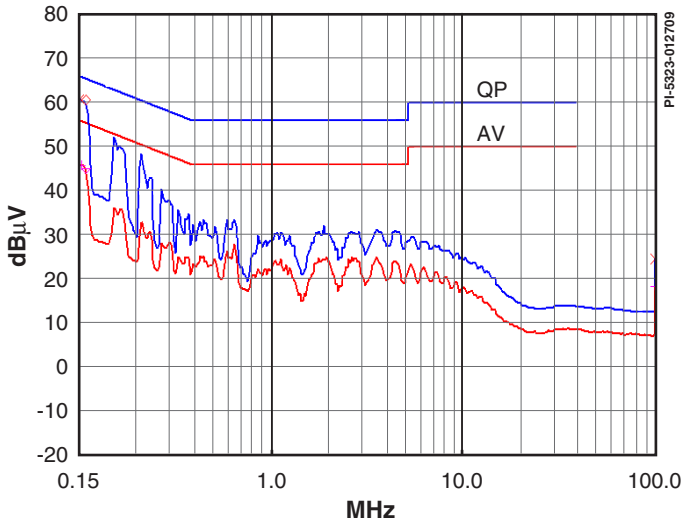

Figure 3. Conducted EMI, 230 VAC Input, EN55015 B Limits, Output RTN Floating.

Transformer Parameters

Core Material	PC44, gapped for ALG of 84.7 nH/t²
Bobbin	EPC13, 10 pin Horizontal
Winding Details	Shield: 24T × 2, 37 AWG Primary: 114T, 35 AWG Feedback: 13T × 3, 35 AWG Secondary: 14T, 30 AWG, TIW
Winding Order	Shield (5–NC), Primary (6–5), Feedback (3–4), Secondary (FLY1–FLY2)
Primary Inductance	1.1 mH, ±10%
Primary Resonant Frequency	750 kHz (minimum)
Leakage Inductance	45 µH (maximum)

Table 1. Transformer Parameters. (AWG = American Wire Gauge, NC = No Connection, TIW = Triple Insulated Wire)

Power Integrations
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1 408-414-9200
Customer Service
Phone: +1-408-414-9665
Fax: +1-408-414-9765
Email: usasales@powerint.com

On the Web
www.powerint.com