Design Idea DI-19

LinkSwitch™ Low Cost 1.5 W CV/CC Charger or Adapter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Charger/Adapter	LNK501	1.5 W	85-265 VAC	5.5 V	Flyback

Design Highlights

- Replaces a linear transformer based supply at the same or lower cost but with much higher performance
- <0.3 W consumption at zero load meets worldwide guidelines (EC's 0.3 W, USA's 1 W for example)
- Extremely simple circuit – only 15 components for production-worthy design
- Primary based CV/CC output – no secondary sense components required
- ±10% output voltage and ±22% output current tolerances at peak power point
- Fully protected for thermal, short circuit and open loop faults
- >62% efficiency (>70% with R1 replaced by an inductor)
- Meets CISPR22B/EN55022B EMI limits with low cost resistive input filter
- Ultra-low leakage current design <5 μA
- EE13 core for low cost and small size

Operation

The AC input is rectified and filtered by D1, D2, C1 and C2. Conducted EMI filtering is provided both by a π filter (C1, R1 and C2) and a differential filter (RF1 and C1). Together with a shield in the transformer (formed from part of the primary) the design meets conducted EMI limits with no Y-capacitor between primary and secondary. Resistor RF1 also functions as a fuse.

LinkSwitch derives all feedback information from the primary. During output diode conduction, the output voltage transformed through the turns ratio is sampled and held by C4. The feedback voltage across C4 (V_{OR}) is converted into feedback current by R2 and fed into the CONTROL pin. This feedback current regulates the output by PWM control during CV operation, and by reducing the internal current limit during CC operation. Below an output voltage of ~2 V, *LinkSwitch* enters auto-restart, limiting average output current to <50 mA. The nominal transition from CV to CC occurs at 5.5 V, 0.27 A. The output envelope characteristic and specification limits are shown in Figure 2.

Together with D3, C4 and R2 are also part of the primary clamp, limiting the peak drain to source voltage due to leakage inductance. Resistor R3 filters the leading edge leakage inductance spike, reducing the error in the feedback voltage. The CONTROL pin capacitor C3 provides energy storage for supply start-up and sets auto-restart timing during fault conditions.

Key Design Points

- Select transformer turns ratio to give a V_{OR} of 40 V to 60 V. Lower values reduce power capability; higher values increase no-load consumption.
- R2 provides 2.3 mA into the CONTROL pin at the peak power point at 85 VAC. The value can be adjusted to center the output voltage.

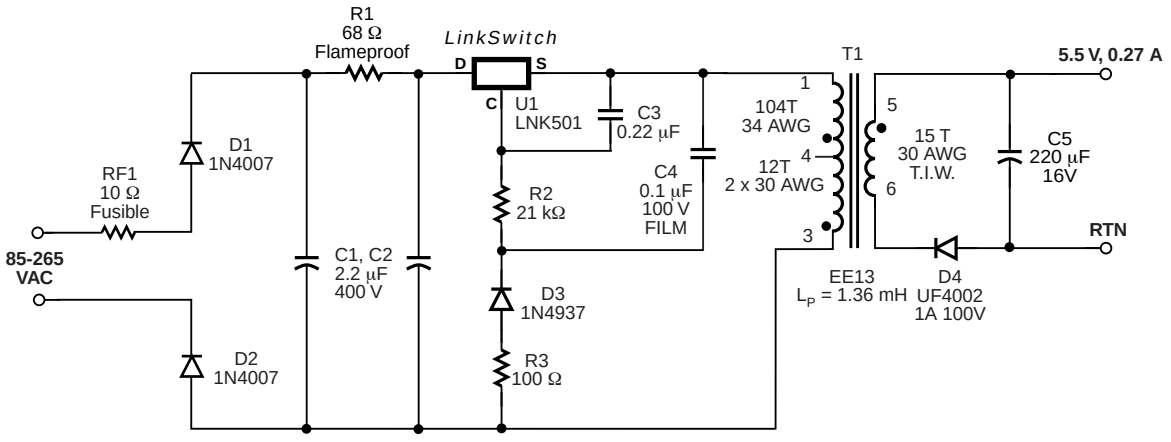

Figure 1. LinkSwitch 1.5 W Charger Power Supply: 85 VAC to 265 VAC Input, 5.5 V, 0.27 A Output

- To maintain the ±22% CC tolerance the primary inductance tolerance should be tighter than ±10%.
- Minimize zero load consumption by reducing drain node capacitance: Use double coated/grade 2 wire for primary and do not vacuum impregnate. Avoid using an RC snubber across the output diode.
- For resistive loads, increase C3 to 1 µF (electrolytic) to allow adequate time for start-up at full load.
- For battery loads, an output π filter is typically not required but can be added for resistive loads to reduce switching ripple.
- R1 can be replaced with an inductor for higher efficiency (~10% increase).
- Adding a 1 mA to 2 mA pre-load reduces zero load voltage by ~1 V but increases power consumption by ~10 mW.
- Diode D4 can be replaced with a Schottky for higher efficiency.
- See AN-35 for more information.

TRANSFORMER PARAMETERS	
Core	TDK PC40 EE13, A_{LG}= 101 nH/T²
Bobbin	EE13 Horizontal 8 pin
Winding Details	Primary: 104T, 34 AWG Shield: 12T, 2 x 30 AWG Secondary: 15T, 30 AWG T.I.W. Flux Band: 1T, 6 mm Cu foil (T.I.W.: Triple Insulated Wire)
Winding Order (pin numbers)	Secondary (5-6), tape, Shield (3-4), tape, Primary (4-1), tape, Flux band (3-NC)
Inductance	Primary: 1.36 mH ±10%, Leakage: 50 µH (max.)
Primary Resonant Frequency	300 kHz (minimum)

Table 1. Transformer Construction Information.

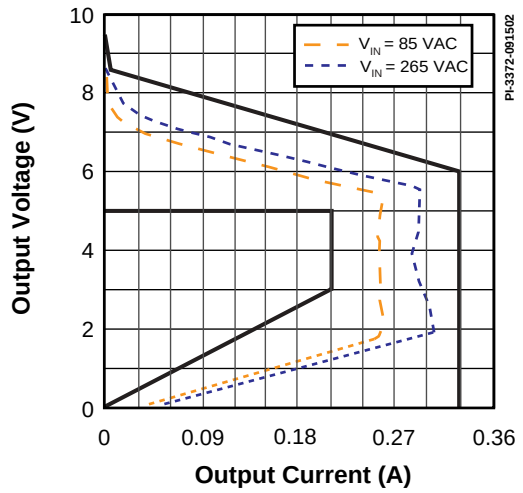

Figure 2. Load Regulation - CV/CC Characteristics with Limits.

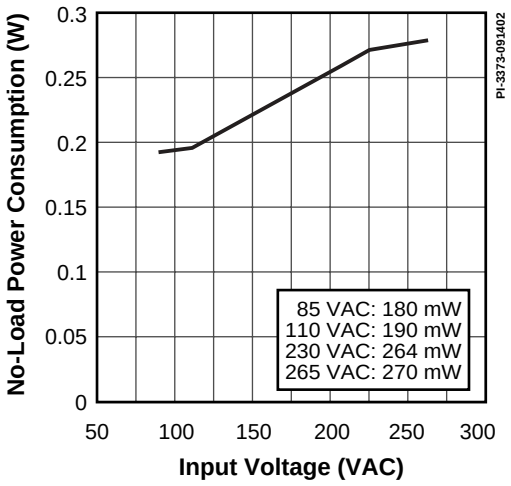

Figure 3. No-load Input Power Consumption.

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