DI-179 Design Idea
LinkSwitch®-XT

2.7 W, Dual Output, Non-isolated Power Supply with High Ambient Temperature Operation

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
White Goods	LNK363PN	2.7 W, 4.15 W pk	185 – 265 VAC	7 V, -5 V	Flyback

Design Highlights

- Low cost, low component count, compact, lightweight linear replacement power supply
- Highly energy efficient
  - Efficiency (>60% at full load)
  - Low input power at no-load (<120 mW at 265 VAC)
- High ambient temperature (70 °C)
- Integrated safety/reliability features:
  - Accurate auto-recovering hysteretic thermal shutdown function maintains safe PCB temperatures under all conditions
  - High thermal shutdown (135 °C) allows for high ambient temperature operation
  - Auto-restart protects against output short circuits and open feedback loops
- Meets CISPR-22/EN55022 B conducted EMI limits with >10 dBμV margin (see Figure 3)

Operation

Energy efficient power supplies generate less heat, which allows them to be used in harsh environments such as white-good applications that usually have a high ambient temperature. Typical operating temperatures for such applications can be as high as 70 ºC to 85 ºC.

The LinkSwitch-XT based non-isolated Flyback power supply shown in Figure 1 operates from 185 VAC to 265 VAC input voltage range and generates two DC outputs: -5 V at 300 mA and 7 V at 175 mA. The 7 V output can be loaded to 350 mA for durations to not impact the thermal rise of U1 significantly.

The AC input is filtered by diode D2 (half-wave rectification) and smoothed by C1 and C6. Inductor L1 forms a pi filter with C1 and C6 to provide differential filtering. The integrated frequency jitter feature of U1 allows such simple EMI filtering to meet compliance with EN55022B, (see Figure 3).

The simple and inexpensive primary clamp (D3, R1 and C3) limits the maximum peak drain voltage to less than the 700 V BV_{DSS} rating of the internal MOSFET.

The LNK363PN (U1) operates at a constant current limit, providing cycle-by-cycle limitation of primary current. The internal controller regulates the output voltage by skipping switching cycles (ON/OFF control) whenever the output voltage is above the reference level.

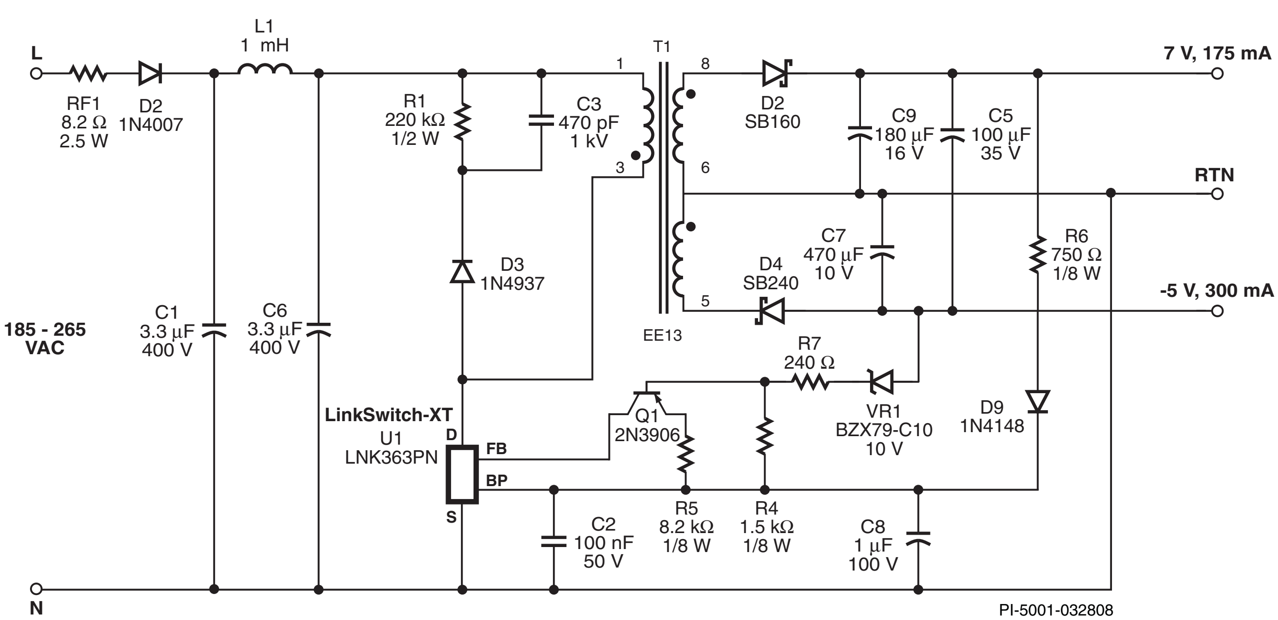

Figure 1. Schematic of a Dual Ouput Power Supply Using LinkSwitch-XT, LNK363PN.

During normal operation, MOSFET switching is disabled whenever the current flowing into the FEEDBACK (FB) pin is greater than 49 µA. If a current less than 49 µA flows into the FB pin when the oscillator's (internal) clock signal occurs, MOSFET switching is enabled for that particular switching cycle, and the MOSFET turns on. That switching cycle terminates when the current through the MOSFET reaches I_{LIMIT}. By adjusting the ratio of enabled to disabled switching cycles, regulation is provided.

The voltage on the BP pin of the LNK363PN is used as a reference to regulate the –5 V output rail. The BP pin holds the emitter of Q1 to 5.8 V with respect to the SOURCE pin. The voltage drop (V_{BE}) across the base-emitter junction of Q1 and VR1 fixes the voltage level at the –5 V output. Transistor Q1 feeds current into the FB pin to disable a switching cycle in order to maintain regulation on the –5 V output.

On/Off control also maximizes efficiency as the effective switching frequency reduces with load, optimizing switching losses. To reduce no-load consumption, the BP pin is fed current from the 7 V output.

The switching device U1 (LNK363PN) is an industry standard DIP-8 (P) package allowing for a very compact design with no external heatsink required. Second suffix N indicates lead-free.

Key Design Points

- Verify that the maximum drain voltage is <650 V at high line and maximum overload conditions. Adjust the values of R1 and C3 as necessary.

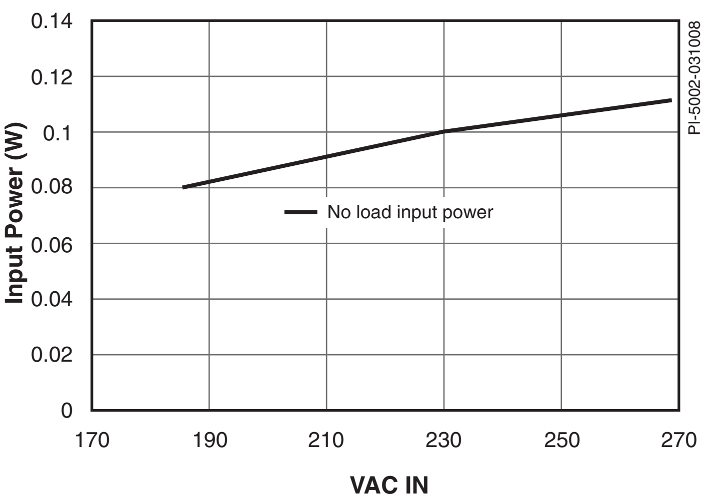

Figure 2. No Load Input Power vs Line Voltage.

- Using the PIXls application, design the transformer for 4.15 W. Use of a low reflected output voltage (VOR) enables better cross-regulation between the 7 V and –5 V outputs.
- The electrically quiet source node of U1 is internally connected to the tab, allowing a large copper area to be used around the SOURCE pins. The maximum temperature rise of the SOURCE pins was measured as 86 ºC at 70 ºC ambient temperature.
- Resistor R6 should be chosen to minimize the no-load power consumption.
- Resistor RF1 is a fusible, flameproof type, allowing it to be used as a low-cost fuse. A wire wound type is recommended to prevent failure due to inrush current.

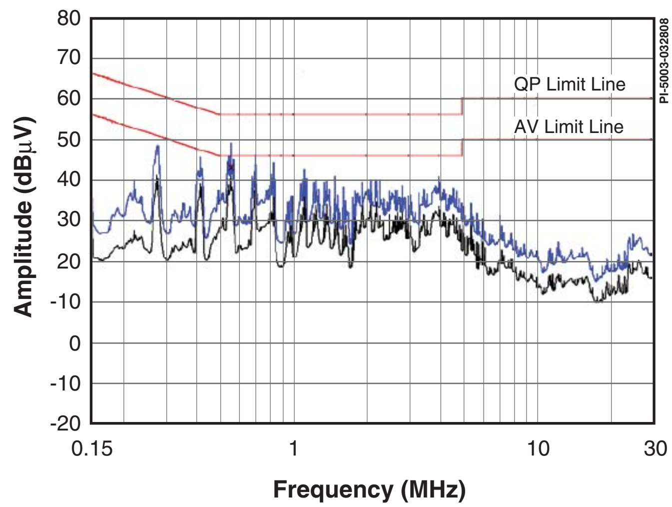

Figure 3. Conducted EMI Scan to EN55022B Limits. Measurements Made at 230 VAC With Output RTN Connected to Earth Ground Representing Worst Case Conditions.

Transformer Parameters	
Core Material	EE13 NC-2H or equivalent, gapped for ALG of 74 nH/t²
Bobbin	EE13, 8 pin, Horizontal
Winding Details	Primary: 175T x 1, 0.1 mm, tape -5 V: 8T x 1, 0.32 mm 7 V: 11T x 1, 0.32 mm
Winding Order	Primary (3–1), -5 V (6–5), 7 V (8–6)
Primary Inductance	2241 µH, ±10%
Primary Resonant Frequency	540 kHz (minimum)
Leakage Inductance	100 µH (maximum)

Table 1. Transformer Parameters. (NC = No Connection)

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