DI-164 Design Idea
LinkSwitch®-LP

1 W, Low Cost, Linear Replacement Power Supply Eliminates Need For Input Electrolytic Capacitor

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Metering	LNK562DN	0.98 W	85 - 265 VAC	7 V	Flyback

Design Highlights

- No input bulk capacitor
  - Improves reliability in areas with severe line voltage fluctuations
  - Saves PCB space and reduces cost compared to stacking two electrolytic capacitors for increased voltage rating
- Highly energy efficient
  - Meets CEC/ENERGY STAR 2008 requirements for active mode efficiency (55% vs 50% requirement)
  - Low input power at no-load (<200 mW no-load consumption at 230 VAC vs 500 mW requirement)
- Low cost, low component count, compact, lightweight linear replacement power supply
  - No optocoupler required
  - No CC sensing resistors required
- Simple EMI filter meets EN55022B limits (see Figure 3)

Operation

Figure 1 shows a universal input 0.98 W output flyback power supply using a LNK562DN. The power supply output is 7 V, 0.14 A (1 W) and has a loose constant-voltage/constant-current (CV/CC) characteristic (see Figure 2). This supply replaces two series electrolytic capacitors with a low value metal film type with a 630 V rating. This is ideal for single phase utility meters or applications that must withstand AC input voltage swells up to 350 VAC for several minutes.

Diodes D1, D2, D3 and D4 rectify the AC input voltage. Differential EMI filtering is provided by C1 and L1. Capacitor C6 provides common mode EMI filtering. The integrated frequency jitter feature of U1, along with transformer E-Shield® techniques, allows such simple EMI filtering to comply with EN55022B limits (see Figure 3).

The primary clamp circuit (D5, R1, and C2) limits the maximum peak drain voltage to less than the 700 V BV_{DSS} rating of the high voltage MOSFET internal to U1. Diode D6 prevents reverse current from flowing through U1, the result of the low value of C1.

The LNK562DN operates at a constant current limit, providing cycle by cycle limitation of the 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. The feedback input circuit at the FB pin consists of a low impedance source follower output set at 1.69 V. During normal operation, MOSFET switching is disabled whenever the current flowing into the FEEDBACK (FB) pin is greater than 70 µA. If a current less than 70 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, the output voltage is regulated.

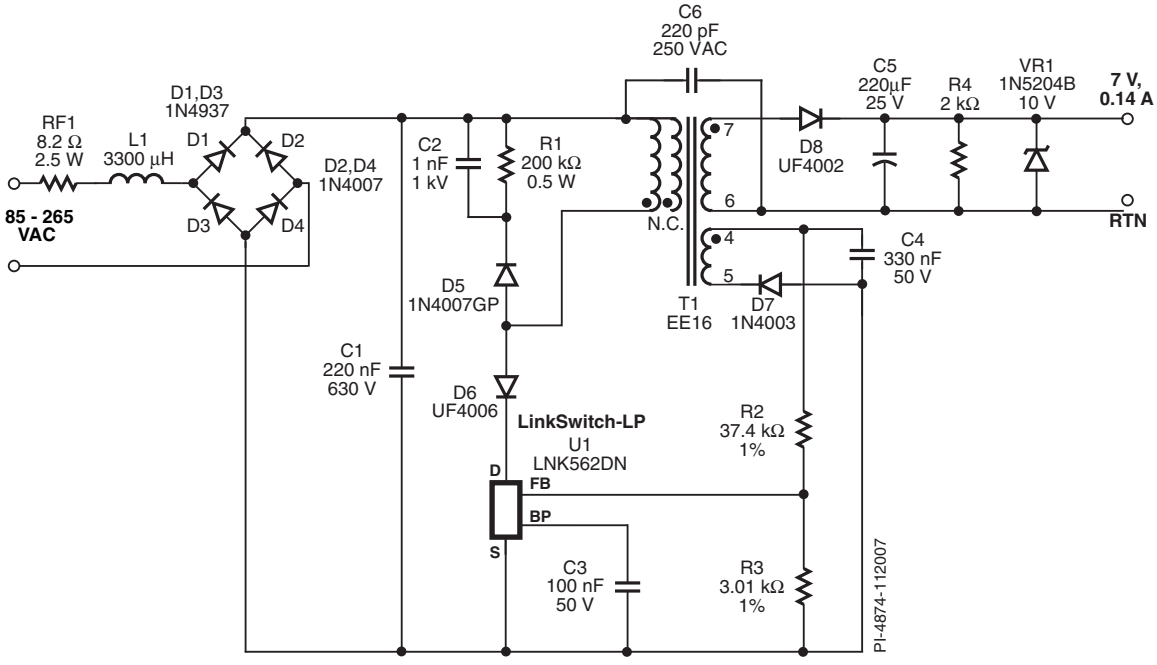

Figure 1. Schematic of a 7 V, 0.14 A Power Supply Using LinkSwitch-LP LNK562DN.

A bias winding is used to provide feedback to U1. Resistors R2 and R3 should be chosen with 1% tolerance for best voltage accuracy. No opto-coupler or CC sense resistor is required to obtain the CV/CC characteristic shown in Figure 2.

Key Design Points

- Verify that the maximum drain voltage is <650 V at high line and maximum overload condition. Adjust the values of R1 and C2 as necessary. However, avoid making the clamp circuit too dissipative (i.e., low value of R1 and high value of C2) as this will increase the no-load power consumption.
- No-load consumption can be further reduced by increasing C4 to 1 µF or higher
- A slow blocking diode was selected for D5. Use only a glass passivated (GP) diode type to ensure a reverse recovery time of 2 µs or less. If unavailable, a fast diode such as FR107 may be substituted. These diode selections recycle some of the clamp energy and increase overall efficiency.
- Capacitor C1 should not be less than 150 nF. This capacitor cannot be eliminated altogether as the switching current must be sourced locally and not directly from the AC input to prevent inductive voltage spikes and increased differential EMI.
- Diodes D1 and D3 are selected as fast diodes for better EMI performance.
- Resistor R4 is a preload resistor to limit no-load output voltage to acceptable limits

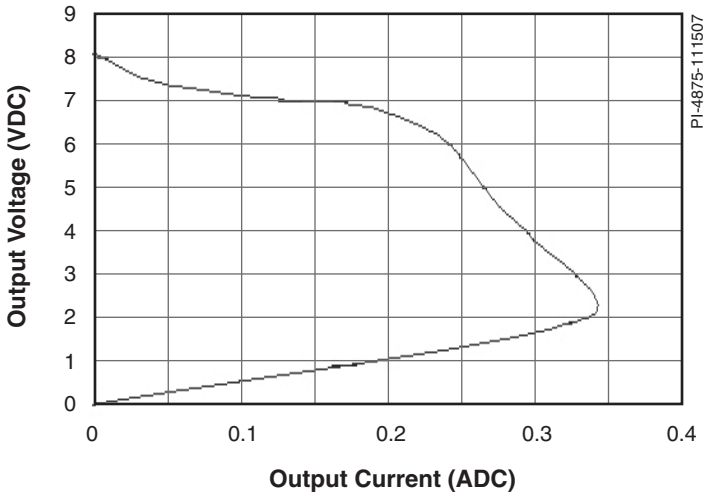

Figure 2. Output VI Characteristics at 230 VAC Input (Measured at Ambient Temperature).

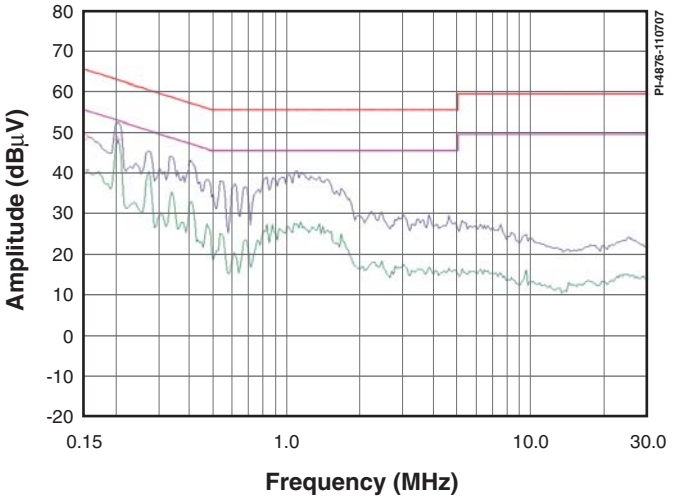

Figure 3. Worst Case Conducted EMI Scan to EN55022 B Limits. (Output RTN Connected to Earth).

Transformer Parameters	
Core Material	EE16 NC-2H or equivalent, gapped for ALG of 237 nH/t^2
Bobbin	EE16, 10 pin horizontal
Winding Details	Bias: 25T x 1, 0.2 mm, tape (reverse wound) Primary: 108T x 1, 0.14 mm, tape Shield: 8T x 3, 0.25 mm, 2 layers tape 7 V: 8T x 1, 0.5 mm TIW, tape
Winding Order	Bias (4-5), Primary (1-2), Shield (NC-2), 7 V (7-6)
Primary Inductance	2749 µH, ±5%
Primary Resonant Frequency	400 kHz (minimum)
Leakage Inductance	75 µH (maximum)

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

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