

# Design Idea DI-76

## LinkSwitch<sup>®</sup>

### 3.1 W Low Parts Count Power Supply



Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Appliance/Industrial Control	LNK520P	3.1 W	100-375 VDC	12 V	Flyback

### Design Highlights

- Replaces a linear transformer based power supply at the same or lower cost, but with much better performance
- High Efficiency: >75% at >100 mA of load current
- Primary side regulated: requires no optocoupler
- <300 mW no-load power consumption at 375 VDC
- Very low parts count: only 9 components!
- 12 V output: ideal for driving motors, relays, or SCRs

### Operation

The very low parts count *LinkSwitch* flyback circuit shown below can be used as a general-purpose power supply or linear adapter replacement.

The design provides regulated output voltage during normal loads as well as a soft output-current limit during overload conditions (such as a stalled motor or defective relay). Adding to this, the other *LinkSwitch* self-protection features of auto-

restart (for hard short circuits) and thermal shutdown effectively produce a very rugged design.

*LinkSwitch* derives all feedback information from the primary side, thus no optocoupler is required. During output diode (D4) conduction, the output voltage is reflected through the transformer turns ratio, providing a primary feedback voltage ( $V_{OR}$ ), which is rectified by diode D3 and held by capacitor C4. Resistor R3 limits the effects of transformer leakage on the feedback voltage. Resistor R2 feeds the  $V_{OR}$  signal as a current to the CONTROL pin of the *LinkSwitch*, controlling duty cycle (and primary current limit during overload conditions). When there is little or no feedback signal (such as a short circuit) the *LinkSwitch* goes into auto-restart, limiting output current to approximately 40 mA.

Capacitor C3 provides device decoupling. The extra winding on pin 3 of T1 is a shield that reduces EMI.

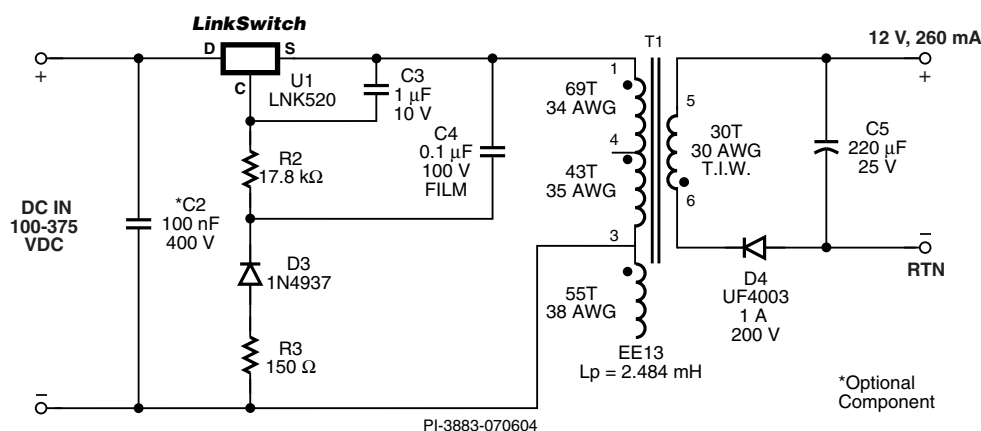


Figure 1. DC-Input, Isolated LinkSwitch 3.12 W Flyback Converter.

## Key Design Points

- The value of C3 (1  $\mu$ F) allows time for the output voltage to develop at startup.
- A larger R3 value will provide flatter voltage regulation if a higher no-load voltage can be tolerated.
- A lower R2 value will reduce the output voltage while proportionally increasing the maximum output current.

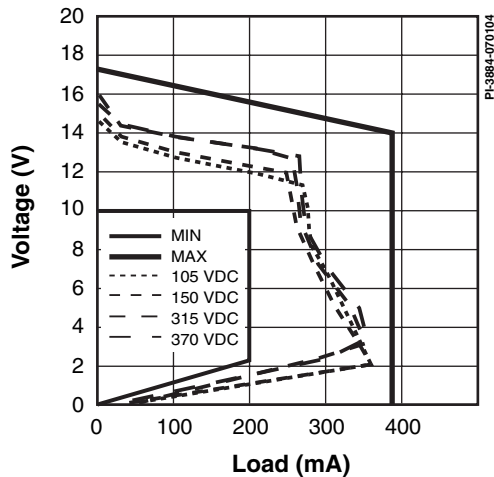


Figure 2. Output Regulation vs. Load Current Curves.

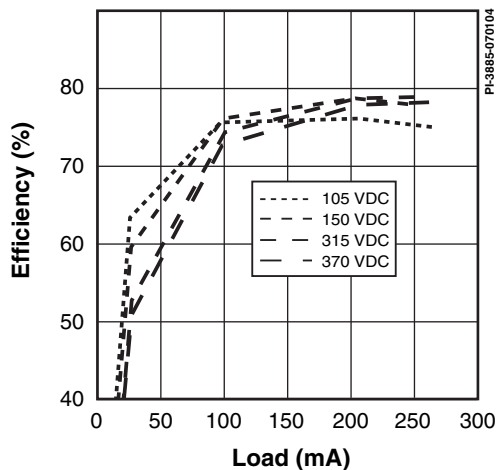


Figure 3. Efficiency vs. Output Current Curves.

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- Output diode D4 needs a sufficient peak inverse voltage (PIV) rating for high line withstand, requiring an ultra-fast 200 V type (UF4003). For lower output voltages (PIV <100 V), Schottky diodes work well and enable improved efficiency.
- The *LinkSwitch* PIXIs spreadsheet tool included in *PI Expert*™ Design Software can be used to redesign the transformer for different output voltages.

TRANSFORMER PARAMETERS	
Core Material	TDK PC40 EE13, $A_{LG} = 199 \text{ nH/T}^2$
Bobbin	EE13 Horizontal 8-pin
Winding Details	Shield 1: 55 T, #38 AWG, 1 Layer Primary-1: 69 T, #34 AWG, 2 Layers Primary-2: 43 T, #35 AWG, 1 Layer Secondary: 30 T, #30 T.I.W., 2 Layers
Winding Order (pin numbers)	Shield 1: (3-Float), Primary-1 (1-4), Primary-2 (4-3), Secondary (6-5)
Primary Inductance	2484 $\mu$ H $\pm$ 10%
Primary Resonant Frequency	500 kHz (minimum)
Leakage Inductance	70 $\mu$ H (maximum)

Table 1. Transformer Design Parameters.

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