Design Idea DI-27

TinySwitch® 3 W AC Adapter: <10 mW No-load Consumption

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Adapter	TNY254	3 W	85-265 VAC	12 V	Flyback

Design Highlights

- Extremely low no-load power consumption (<10 mW at 115/230 VAC input)
- Simple RC snubber/clamp reduces EMI
- Low cost, low component count solution

Operation

The *TinySwitch* flyback converter in Figure 1 generates an isolated 12 VDC, 3 W output from 85 VAC to 265 VAC input. Typical applications include wall mounted AC adapters for consumer products.

The key performance characteristic of the circuit shown is extremely low no-load consumption of <10 mW. A linear transformer adapter of similar rating will typically consume 1 W to 4 W at no-load. At $0.12/kWh, the *TinySwitch* can therefore reduce energy costs by $1 to $4 per year.

The no-load performance is achieved using a transformer bias winding as a low voltage source for *TinySwitch* operating current. Even without this winding, a *TinySwitch* circuit will consume <100 mW at no-load. However, by providing external bias, the internal high voltage current source, which normally powers the IC from the DRAIN pin, is disabled and a further reduction in consumption is therefore achieved.

The bias winding should provide enough current to fully disable the internal current source. Figure 2 shows that the bias winding and choice of C5 and R3 should provide 250 μA to 300 μA at no-load to minimize consumption. Zener VR3 is required to clamp the BYPASS pin voltage.

The output Zener VR2 is not biased, minimizing the secondary circuit consumption. A low current Zener therefore provides the best output voltage tolerance.

Components R2 and C3 provide a low cost clamp and also help reduce EMI by softening switching edges. This type of snubber increases switching losses and would therefore normally be avoided in low consumption circuits. However, with *TinySwitch*, these losses are negligible at no-load as switching frequency is so low. This is illustrated in Figure 3 where replacing R2 and C3 with a Zener clamp across the primary winding reduces consumption by <0.25 mW.

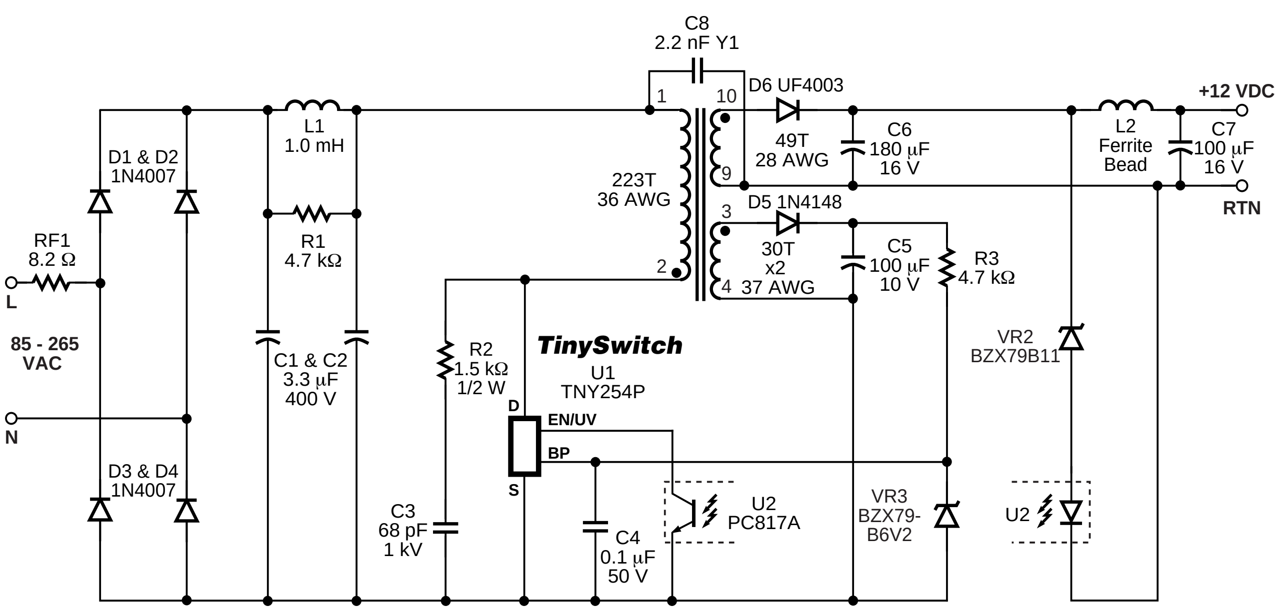

Figure 1. 3 W AC Adapter with <10 mW No-load Consumption.

Key Design Points

- Design bias winding circuit to provide 250 μA to 300 μA at no-load.
- Ensure C5 is large enough to supply above current at the very low no-load switching frequencies.
- Minimize secondary circuit bias currents. Use low current feedback Zeners for best tolerance.
- Zener or RCD clamp can be used to slightly reduce no-load consumption further. Use a 200 V Zener or maximize resistor value in RCD clamp for lowest losses.
- Design transformer with low reflected voltage to minimize clamp losses.
- Wind transformer for lowest leakage inductance. Choose wire gauges to completely fill winding layers.
- Wind transformer with tape between primary layers to further reduce intra-winding capacitance.

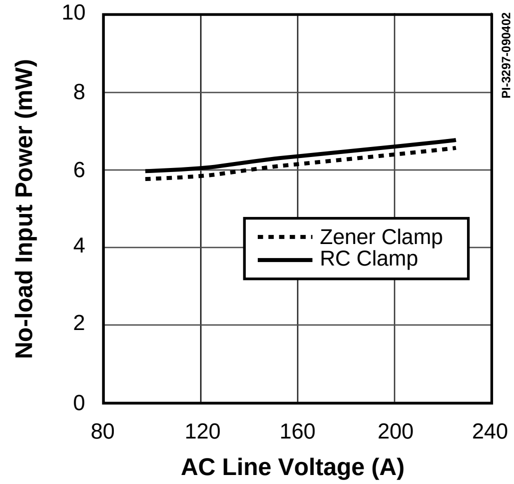

Figure 3. No-load Input Power Variation with Input Voltage.

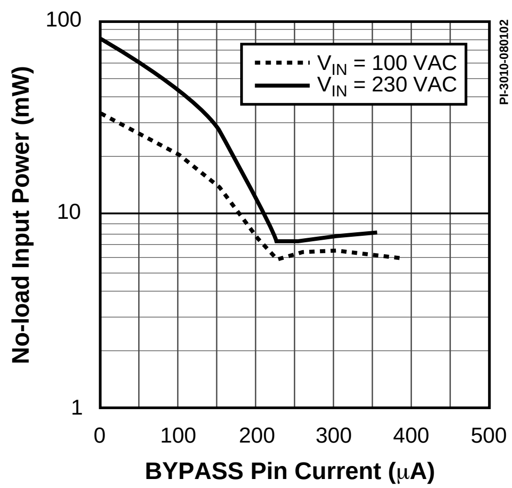

Figure 2. No-load Input Power vs. BYPASS Pin Current.

TRANSFORMER PARAMETERS	
Core Material	EE16 Nippon Ceramic NC-2H A_L of 74 nH/T^2
Bobbin	EE16 10 pin (Ying Chin YC1607 or equivalent)
Winding Order (pin numbers)	Primary (1-2), Tape 12 V (10-9), Tape Bias (3-4), Tape
Primary Inductance	3.67 mH ±10%
Primary Resonant Frequency	500 kHz (minimum)
Leakage Inductance	300 μH (maximum)

Table 1. Transformer Construction Information.

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