Design Idea DI-84
TinySwitch®-II 3 W Charger: <30 mW No-load Consumption

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Charger	TNY264P	3 W	85-265 VAC	5 V, 600 mA	Flyback

Design Highlights

- Less than 30 mW no-load power consumption (for 115/230 VAC input)
- Meets CISPR-22 Class B without Y capacitor
- Low cost, low component count solution
- Meets CEC active mode efficiency with good margin

Operation

The *TinySwitch-II* flyback converter in Figure 1 generates a constant voltage, constant current (CV/CC) 5 V, 600 mA output. Typical applications include wall-mounted chargers for cell phones, PDAs and other battery powered portable equipment.

The key performance characteristic of the circuit shown is the extremely low no-load consumption of <30 mW. A linear transformer charger of similar rating will typically consume 1 W to 4 W at no-load. At $0.12/kWh, the *TinySwitch-II* can therefore reduce energy costs by $1 to $4 per year.

This no-load performance is achieved by using a transformer bias winding as a low voltage source for *TinySwitch-II* operating current. Even without this winding, a *TinySwitch-II* circuit will consume <300 mW at no-load. The bias winding disables the internal high voltage current source, which normally powers the IC from the DRAIN pin, thereby further reducing power consumption.

The bias winding should provide enough current to fully disable the internal current source at no-load. Other load conditions are not important, as the device will be powered from the DRAIN pin if bias is lost. This allows a simple flyback winding to be used. Figure 2 shows that the bias winding and choice of R2 should provide approximately 600 µA at no-load to minimize consumption.

The circuit meets CISPR-22 Class B conducted EMI limits without a Y capacitor, and therefore has very low AC leakage current. Superior EMI performance is achieved via the *TinySwitch-II* frequency jitter, an output RC snubber, use of the bias winding as a shield, and careful selection of clamp Zener voltage.

Key Design Points

- Design bias winding circuit to provide approximately 600 µA at no-load. Figure 2 shows the details.
- Minimize secondary circuit bias currents. Use low current feedback Zeners for best tolerance. The very low Zener bias current in this design will provide better than ±10% output voltage tolerance.
- Design transformer with low reflected voltage to minimize clamp losses. A larger device (TNY266) may enable further reduction in V_{OR}.
- Wind transformer for lowest leakage inductance. Choose wire gauges to completely fill winding layers.

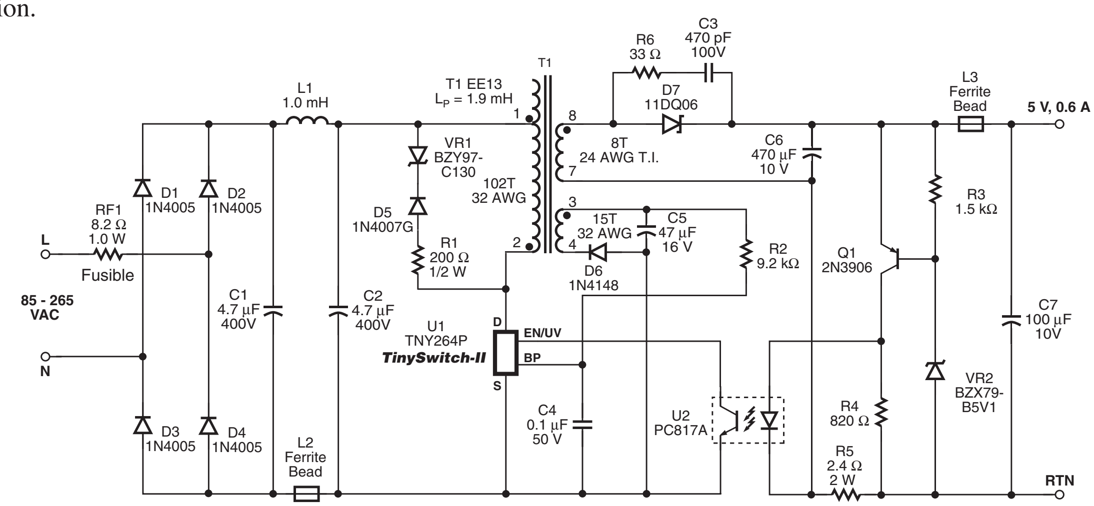

Figure 1. TinySwitch-II 3.0 W Cell Phone Charger.

- Winding transformer with tape between primary layers further reduces intra-winding capacitance and no-load consumption.

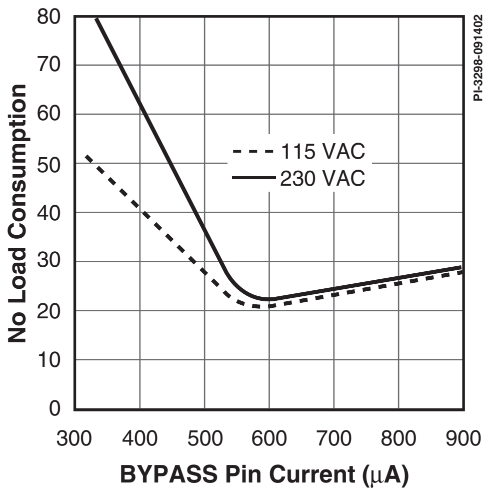

Figure 2. No-load Input Power vs. BYPASS Pin Current.

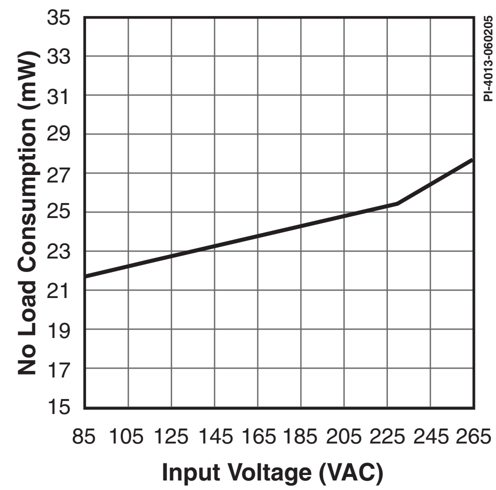

Figure 3. No-load Input Power vs. Line Voltage.

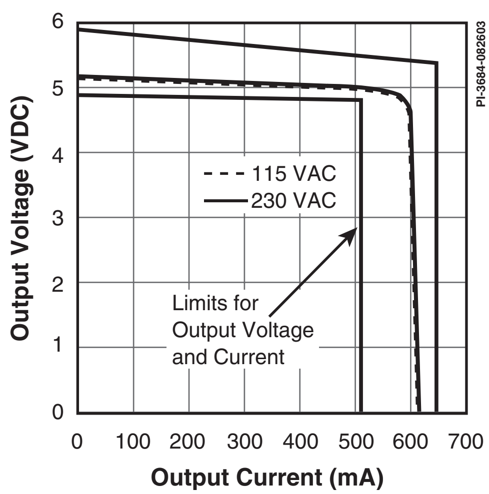

Figure 4. 5.0 VDC, 600 mA CV/CC Curve.

TRANSFORMER PARAMETERS	
Core Material	EE13 TDK PC40, or equivalent AL of 128 nH/T2
Bobbin	EE13, 8 pin
Winding Order (pin numbers)	Primary: 1-2, tape, Bias: 3-4, tape, Secondary: 7-8, 5 V, tape
Primary Inductance	1.9 mH ±10%
Primary Resonant Frequency	500 kHz (min)
Leakage Inductance	50 µH (max)

Table 1. Transformer Construction Information.

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