Design Idea DI-28

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

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.

The 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. 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 at no-load. Other load conditions are not important as the device will be powered from the DRAIN pin if bias is lost, allowing a simple flyback winding to be used. Figure 2 shows that the bias winding and choice of R2 should provide approximately 550 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. *TinySwitch-II* frequency jitter, use of the bias winding as a shield and capacitor C3 to soften leakage inductance spikes combine to provide the EMI performance.

Key Design Points

- Design bias winding circuit to provide approximately 550 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 bias current in this design will provide approximately ±10% output voltage tolerance. A precision reference (e.g. TL431) can be used to reduce this if required.
- Design transformer with low reflected voltage to minimize clamp losses. A bigger device (TNY266) may help to further reduce V_{OR}.
- Wind transformer for lowest leakage inductance. Choose wire gauges to completely fill winding layers.
- Winding transformer with tape between primary layers further reduces intra-winding capacitance and no-load consumption.

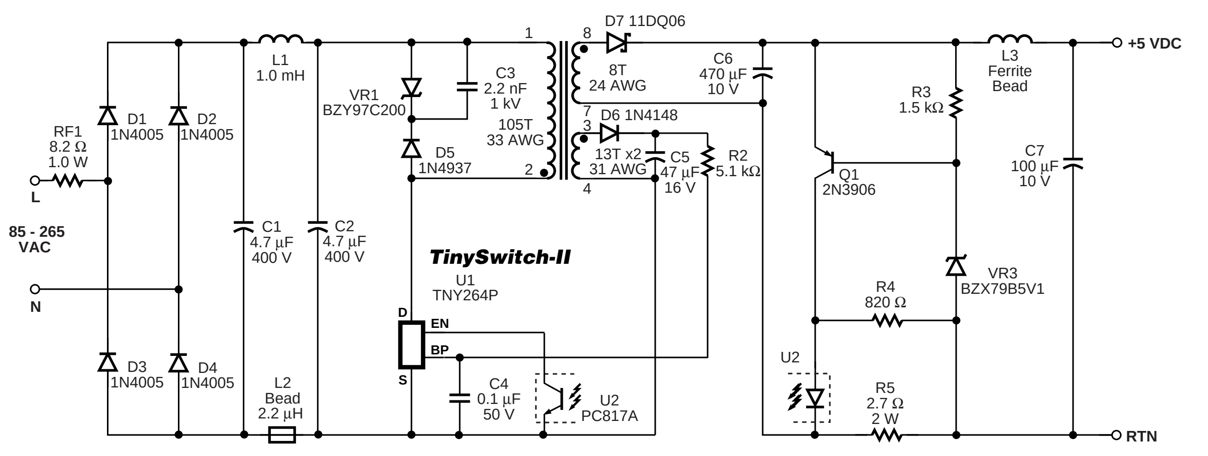

Figure 1. TinySwitch-II 3.0 W Cell Phone Charger.

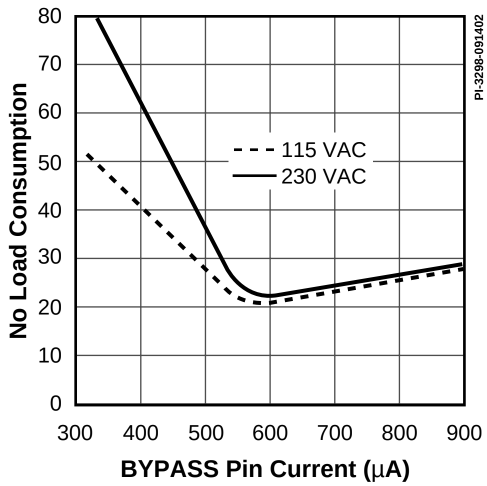

Figure 2. No-load Input Power vs. BYPASS Pin Current.

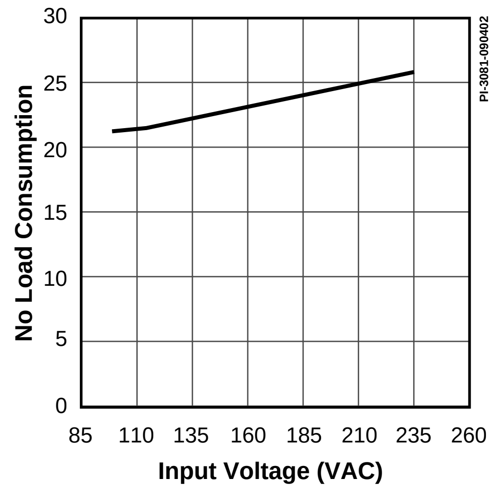

Figure 3. No-load Input Power vs. Line Voltage.

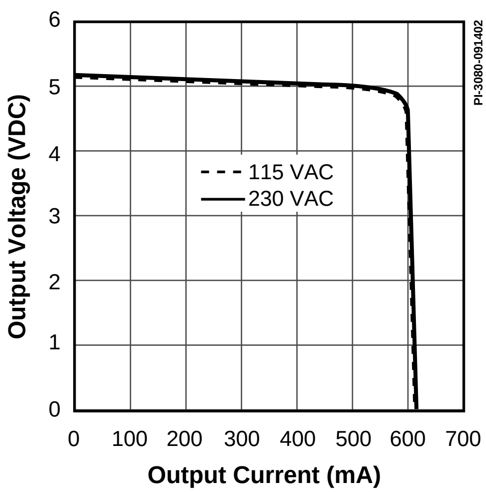

Figure 4. 5.0 VDC, 600 mA CV/CC Curve.

TRANSFORMER PARAMETERS	
Core Material	EE13 TDK PC40, or equivalent A_L of 128 nH/T^2
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 (minimum)
Leakage Inductance	50 µH (maximum)

Table 1. Transformer Construction Information.

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