Design Idea DI-34
TinySwitch®-II
5 W Universal Adapter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Adapter	TNY266P	5 W	85-265 VAC	5 V	Flyback

Design Highlights

- Simple design: low parts count (23)
- <300 mW no-load without transformer bias winding
- Frequency jittering reduces EMI - meets EN55022 Class B with no Y capacitor: very low primary-to-secondary leakage current
- ±7% output tolerance with simple Zener reference
- High Frequency (132 kHz) operation allows small, low cost EE16 transformer
- Built-in thermal shutdown protection
- ON/OFF digital regulation: No analog control loop to compensate

Operation

Figure 1 is a simple flyback converter utilizing several *TinySwitch-II* built-in features such as switching frequency jittering, thermal shutdown and auto-restart fault protection.

Typical applications are wall mount adapters and other AC/DC applications requiring very low cost and small size. The ability to meet EMI requirements with no Y capacitor makes this circuit ideal for applications requiring low primary-to-secondary leakage currents.

The *TinySwitch-II* frequency jitter feature and transformer construction allow use of a simple filter (L1, L2, C1 and C2) to meet EMI requirements with L2 used to attenuate high frequency EMI in the radiated spectrum (>30 MHz). The circuit also uses a low cost RCD clamp (C7, D5, R3, and R4). Diode D5 is a Glass Passivated (GP) general purpose diode, allowing partial recovery of the leakage energy by recirculating clamp current during the D5 reverse recovery time, thus improving efficiency. Resistor R3 reduces EMI by limiting the peak D5 reverse current and thus softening its recovery characteristic.

The combined voltage drops of Zener diode (VR7) and optocoupler diode (U2) set the output voltage. Resistor R7 biases VR7 according to its specification. The *TinySwitch-II* feedback current is independent of load allowing ±7% output voltage tolerance with this simple Zener reference.

Due to the digital nature of the *TinySwitch-II* control scheme, no loop compensation is required. In addition, the current transfer ratio (CTR) of the optocoupler is not critical and no DC gain setting resistor in series with VR7 is required.

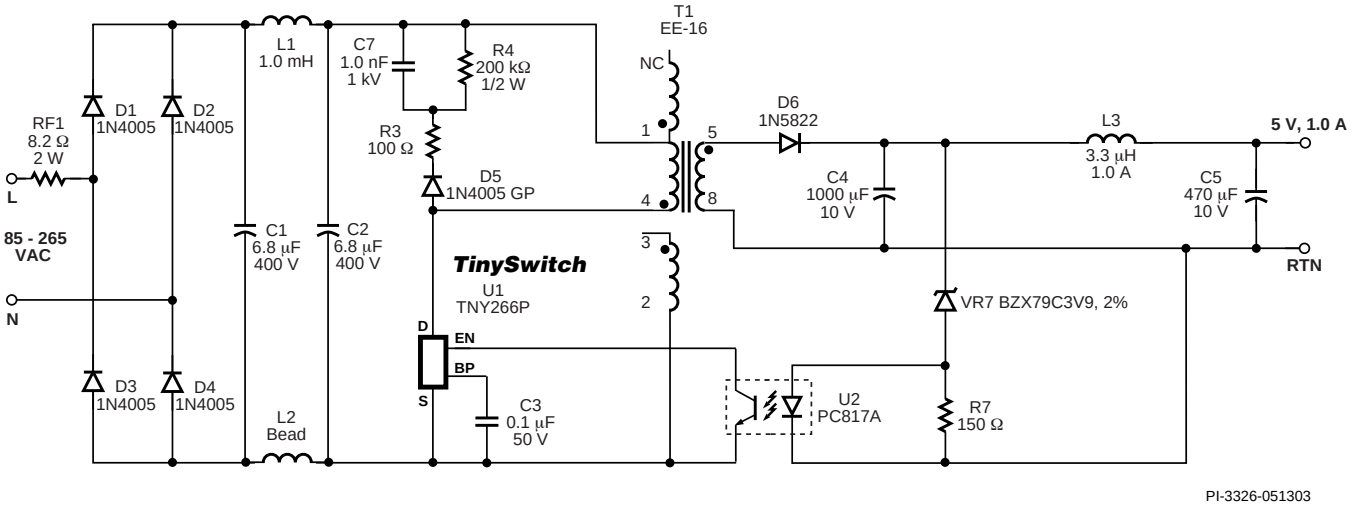

Figure 1. TinySwitch-II – TNY266P, 5 V, 1 A, 5 W Charger-Adapter Power Supply.

Key Design Points

- Use K_{RP} (ripple-to-peak current ratio) in the range of 0.4 to 0.6 and V_{OR} (output reflected voltage) of 90 V to 110 V for best efficiency.
- Use low cost optocoupler - gain is non-critical.
- PCB traces which carry high switching voltages and current should be short and wide to reduce EMI.
- Reduce leakage inductance by filling each winding layer across the entire width of the bobbin.
- R4 should be large enough to limit dissipation, to meet <300 mW no-load target, while still limiting peak DRAIN voltage to a safe value – 200 kΩ is a good start value for most designs.
- A layer of insulation tape between each layer of primary winding will further reduce inter-winding capacitance and therefore switching losses.
- Ferrite bead L2 reduces radiated EMI.

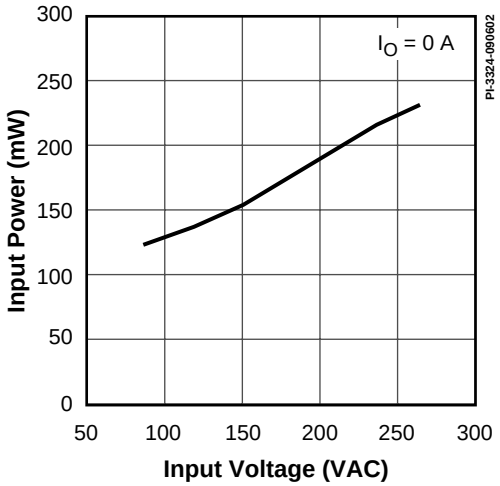

Figure 2. No-load Input Power Consumption.

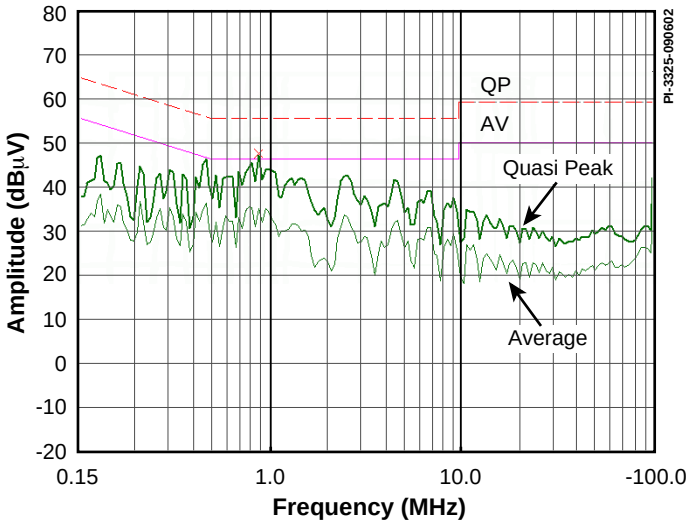

Figure 3. Conducted Emissions–EN55022 Class B (QP and AVG), 5 V, 1 A, 230 VAC, with Artificial Hand Connected to Secondary Return.

TRANSFORMER PARAMETERS	
Core	EE16, Nippon Ceramic NC-2H or equivalent, A_L = 135 nH/T^2
Bobbin	EEL16 Vertical
Winding Order (pin numbers)	Shield (1-NC), Primary (4-1), Shield (3-2), and Secondary (10-8).
Primary Inductance (Pins 1-4 all others open)	1660 µH ±10%
Primary Resonant Frequency (Pins 1-4, all other open)	400 kHz (minimum)
Leakage Inductance (Pins 1-4, with Pins 8-14 shorted)	70 µH (maximum)

Table 1. Transformer Design Parameters.

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