TinySwitch®-II Family

Enhanced Energy Efficient Low Power Off-line Switcher IC

JUNE 2004

NEW! TNY263 and TNY265 Family Members Expand the Coverage for Low Power Applications

Features & Benefits

Better Cost/Performance Over RCC & Linears

- Very tight tolerances and negligible temperature variation on key parameters eases design and lowers cost
- Expanded scalable device family for low system cost
- Lower system cost than RCC, discrete PWM and other integrated/hybrid solutions
- Cost effective replacement for bulky regulated linears
- Simple design practically eliminates rework in manufacturing

High Performance at Low Cost

- Simple ON/OFF control–no loop compensation needed
- No bias winding–simpler, lower cost transformer
- High voltage powered–ideal for charger applications
- High bandwidth provides fast turn on with no overshoot
- Current limit operation rejects line frequency ripple
- Built-in current limit and thermal protection improves safety

EcoSmart® - Extremely Energy Efficient

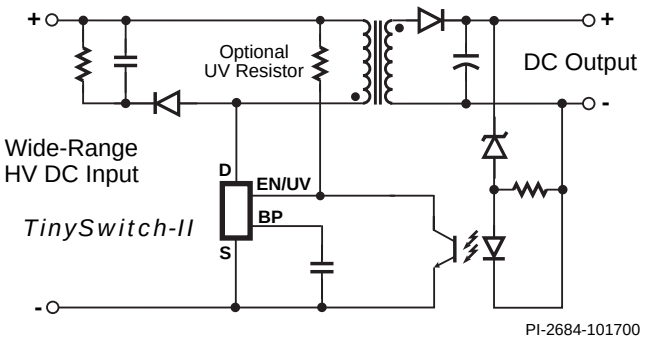
- No load consumption <50 mW with bias winding and <250 mW without bias winding at 265 VAC input
- Meets Blue Angel, Energy Star, and EC requirements
- Ideal for cell-phone charger, DVD player, and PC standby applications

EcoSmart®

Product Highlights

- Fully integrated auto-restart for short circuit and open loop fault protection–saves external component costs
- Programmable line under-voltage detect feature prevents power on/off glitches–saves external components
- Frequency jittering dramatically reduces EMI (~10 dB)–minimizes EMI filter component costs
- 132 kHz operation reduces transformer size–allows use of EF12.6 or EE13 cores for low cost and small size
- Built-in circuitry practically eliminates audible noise with ordinary dip-varnished transformer

Typical Flyback Application



Output Power Table

PRODUCT	230 VAC ±15%		85-265 VAC	
	Adapter	Open Frame	Adapter	Open Frame
TNY263 P or G	5 W	7.5 W	3.7 W	4.7 W
TNY264 P or G	5.5 W	9 W	4 W	6 W
TNY265 P or G	8.5 W	11 W	5.5 W	7.5 W
TNY266 P or G	10 W	15 W	6 W	9.5 W
TNY267 P or G	13 W	19 W	8 W	12 W
TNY268 P or G	16 W	23 W	10 W	15 W

See Data Sheet for Additional Notes and Conditions.

P = DIP-8

G = SMD-8

TinySwitch®*-II* Family Design Tools

Power Supply Design Software

With *PI Expert*™, you're only "mouse-clicks" away from determining the key components in your next switching power supply design, including the best Power Integrations power IC and design details for the transformer! It's fast & easy...and best of all, **FREE!**

Design Accelerator Kit (DAK)

DAKs include a working prototype power supply, sample devices, unpopulated pcb, data sheet, comprehensive engineering report & other related documentation.

DAK-14A	3 W, 9 V Universal Input Charger/Adapter

TinySwitch-II Product & Design Collateral*

Data Sheet	**TNY263-268**	***TinySwitch-II*** Family Data Sheet
Design Ideas[1]	**DI-77**	Application: Charger/Adapter (3 W, 9 V, Universal Input), <200 mW No-load
	DI-63	Application: Charger/Adapter (4.8 W, 6 V, Universal Input)
	DI-62	Application: Charger/Adapter (3 W, 5 V, Universal Input), <30 mW No-load
	DI-61	Application: Charger/Adapter (3 W, 5 V, Universal Input), <200 mW No-load
	DI-34	Application: Charger/Adapter (5 W, 5 V, Universal Input)
	DI-33	Application: DVD Player (11 W, 17 W Peak, 3.3 V / 5 V / 12 V / -12 V, Universal Input)
	DI-28	Application: Charger/Adapter (3 W, 5 V, Universal Input), <30 mW No-load
	DI-13	Application: Charger/Adapter (3 W, 9 V, Universal Input)
	DI-11	Application: General Purpose (1.2 W, 12 V, Universal Input Buck Converter)
Engineering Prototype Reports[2]	**EPR-62**	Application: Charger/Adapter (3 W, 5 V, Universal Input), <30 mW No-load
	EPR-29	Application: DVD Player (11 W, 15.5 W Peak, 3.3 V / 5 V / 12 V / -12 V, Universal Input)
	EPR-14	Application: Charger/Adapter (3 W, 9 V, Universal Input) (DAK-14)
	EPR-9	Application: Appliance (5 W, 5 V / 12 V, Universal Input)
Design Example Reports[3]	**DER-35**	Application: Charger/Adapter (3.5 W, 5.5 V, Universal Input)
	DER-33	Application: Charger/Adapter (3.9 W, 6.5 V, Universal Input), <80 mW No-load
	DER-11	Application: PC Standby (15 W, 5 V / 13 V)
	DER-10	Application: DVD Player (4.9 W, 8.5 W Peak, 5 V / 3.3 V / 12 V / -12 V, Universal Input)
	DER-09	Application: DVD Player (4.4 W, 5.7 W Peak, 5 V / 3.3 V / 12 V / -12 V, Universal Input)
	DER-08	Application: DVD Player (9 W, 11 W Peak, 5 V / 3.3 V / 12 V / -12 V / -22 V / 4 V, Universal Input)
	DER-07	Application: DVD Player (9 W, 10.5 W Peak, 5 V / 3.3 V / 12 V / -12 V / -23 V / 3 V, Universal Input)
	DER-06	Application: Charger/Adapter (3.6 W, 5.1 V, Universal Input)
	DER-05	Application: DVD Player (11 W, 17 W Peak, 3.3 V / 5 V / 12 V / -12 V)
	DER-04	Application: Charger/Adapter (2.4 W, 6 V, Universal Input)
	DER-03	Application: Charger/Adapter (2.4 W, 6 V, Universal Input)

1. Design Ideas (DI) - Design Ideas are two-page documents describing real world applications using Power Integrations' ICs. All necessary information is provided for building the circuit. *2. Design Example Report (DER)* - Design Example Reports contain a power supply design specification, schematic, bill of materials, and transformer documentation. Performance data and typical operation characteristics are included. This design has had very limited production (typically a one-off design). *3. Engineering Prototype Report (EPR)* - Engineering Prototype Reports contain a power supply reference design specification, schematic, bill of materials and transformer documentation. Performance data and typical operating characteristics are also included. The design has been produced in small quantities for use in our Design Accelerator Kits.

* Downloadable from ***www.powerint.com***

Design Idea DI-77

TinySwitch®-II 3 W Adapter: <200 mW No-Load Consumption

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Adapter	TNY263P	3 W	85-265 VAC	9 V / 330 mA	Flyback

Design Highlights

- Replaces a linear transformer based power supply at the same or lower cost, but with much higher performance
- <200 mW no-load consumption (at 115/230 VAC)
- Meets CISPR 22-B with >15 dB margin, w/o Y capacitor
- Low cost, low component count solution: only 24 parts!
- *TinySwitch-II* On/Off regulation scheme produces ±5% output regulation over temperature with a 2% Zener
- Does not require a transformer bias winding

Operation

This *TinySwitch-II* based flyback converter produces an isolated 3 W, 9 VDC output from an 85 VAC to 265 VAC input. Fusible resistor RF1 gives short circuit fault protection and limits startup inrush current. Inductors L1 and L2 and capacitors C1 and C2 form a low-cost pi (π) filter that attenuates conducted EMI. In addition, the internal frequency jitter of the *TinySwitch-II*, the use of shield windings, an output RC snubber, and a primary-side RCD clamp makes the circuit meet CISPR-22 Class B conducted EMI limits without a Y capacitor, resulting in a very low value of AC leakage current (<300 μA).

The key performance characteristic of this circuit is the extremely low no-load power consumption of <200 mW (a similarly rated linear transformer adapter will typically consume approximately 1 W under no-load). This low no-load consumption is the result of the inherent cycle skipping feature of the *TinySwitch-II* and careful transformer design.

Key Design Points

- Minimize secondary-side power consumption. Zener diode VR1 receives its bias current from the opto-LED in U2. Using a low current device minimizes consumption while providing an output voltage tolerance of ±5%. A TL431 can be used for tighter output voltage accuracy.
- Minimize clamp losses: design the transformer to have a low reflected voltage (V_{OR}). In this case, V_{OR} was set to ≈ 90 V.
- Minimize leakage inductance: select wire gauge sizes that completely fill each winding layer of the transformer.
- Minimize intra-winding capacitance and no-load consumption: put a layer of tape between each primary winding layer.
- Use >200 kΩ resistor in the RCD clamp to further reduce power losses if the following two conditions are met: 1) the EMI performance is not compromised, and 2) there is enough drain voltage (BV_{DSS}) margin for the internal MOSFET.

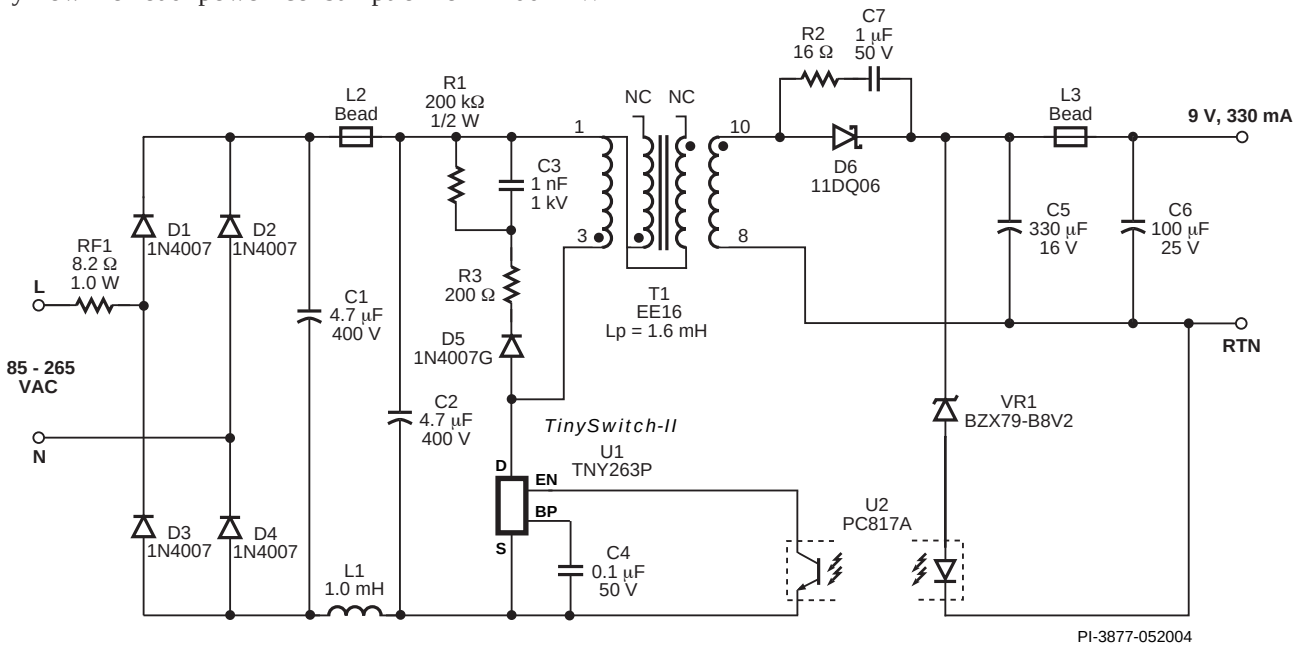


Figure 1. TinySwitch-II 3.0 W Adapter.

TRANSFORMER PARAMETERS	
Core Material	TDK PC40 EE16, A_L = 190 nH/T^2
Bobbin	EE16 Horizontal 10 pin
Winding Details	Core Cancellation: 26T, 2 x 36 AWG Primary: 46T + 46T, 35 AWG Shield: 8T, 2 x 26 AWG Secondary: 10T, T.I.W. 24 AWG
Winding Order (pin numbers)	Core Cancellation (1-NC), 2 x Tape, Primary (3-1), Tape, Shield (2-NC), 2 x Tape, Secondary (10-8)
Primary Inductance	1.60 mH ±10%
Primary Resonant Frequency	600 kHz (minimum)
Leakage Inductance	50 μH (maximum)

Table 1. Transformer Construction Information.

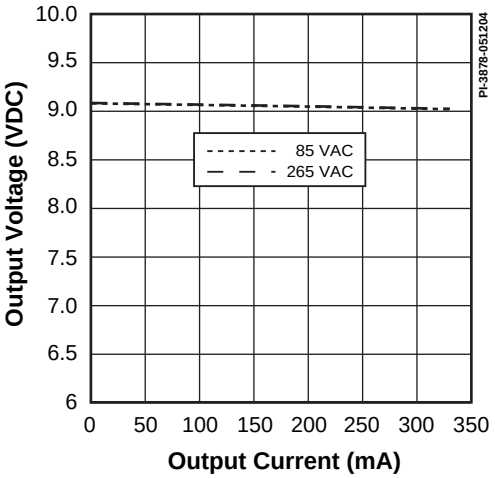


Figure 3. Load Regulation–CV Characteristics.

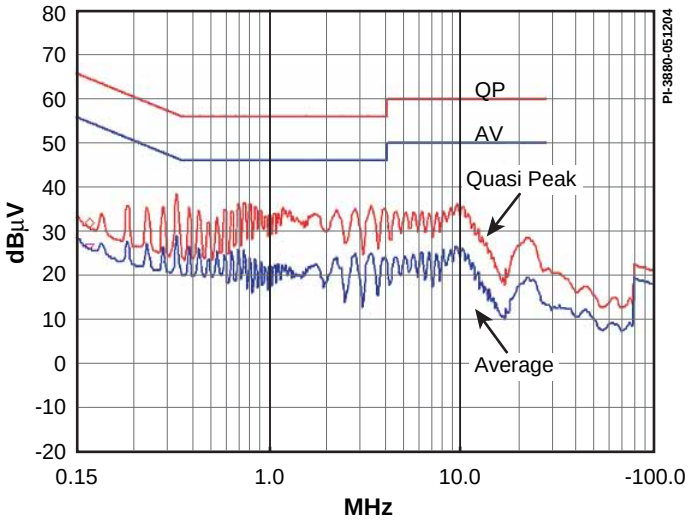


Figure 2. Conducted EMI, Full-Load, 230 VAC, Power Return Connected to "Artificial Hand" of LISN.

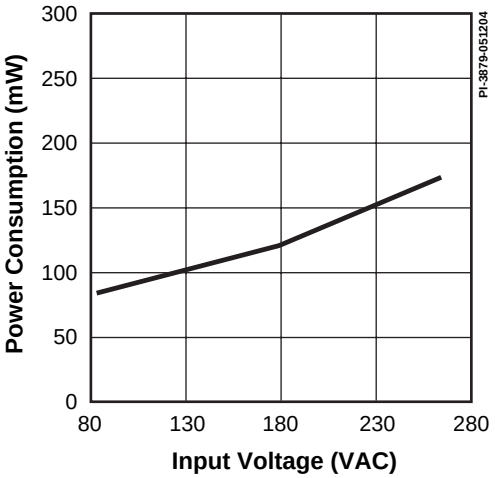


Figure 4. No-Load Input Power Variation with Input Voltage.

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