

# DI-140 Design Idea

## TinySwitch-III

### 10 W Adapter for Portable Audio Players with Latching Overvoltage and Over-Temperature Shutdown Protection

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
MP3/Audio Players	TNY278PN	10 W	90 – 265 VAC	5 V ±5%	Flyback

#### Design Highlights

- Universal input voltage range – single design worldwide
- Highly energy efficient
  - Meets CEC/ENERGY STAR 2008 requirements for active mode efficiency (72.5% vs 70.7% requirement)
  - Low no-load input power (<200 mW at 230 VAC)
- Excellent EMI margin
  - Meets CISPR-22/EN55022B EMI limits with >10 dB $\mu$ V margin
  - Conducted scan >30 MHz indicates good radiated EMI performance
- Extended protection features
  - Latching Overvoltage Protection (OVP)
  - Latching Over-Temperature protection (OTP)

#### Operation

The flyback power supply shown in Figure 1 employs a TNY278PN (U1) to generate a 5 V, 2 A output from a 90-265 VAC input. Applications include portable audio players, USB chargers, and equipment requiring a 5 V output.

Optocoupler feedback using a reference IC was selected to provide accurate and tight output regulation. The feedback signal is fed into the EN/UV pin of U1. IC U1 uses On/Off control to adjust the ratio of enabled to disabled switching cycles to regulate the output. This also optimizes the efficiency of the converter vs. load, providing the flat characteristic shown in Figure 2, which is ideal for meeting active-mode energy efficiency requirements.

Output overvoltage protection is provided via the latching shut-down feature of U1. Should the feedback loop open due to component failure, the resulting rise in output voltage is reflected into the bias winding output voltage across C20. Once above the sum of the rating of VR1 and the BP/M pin voltage (~12.5 V), current flows into the BP/M pin. Latching shutdown is triggered when this current exceeds 6.5 mA. MOSFET switching is disabled until the BP/M pin capacitor (C4) is discharged below 4.8 V after removal of input AC.

A separate case internal ambient temperature shutdown is provided by Q1, C5, RT1, and R6, in addition to the integrated 142 °C shutdown of U1. As the temperature, and therefore

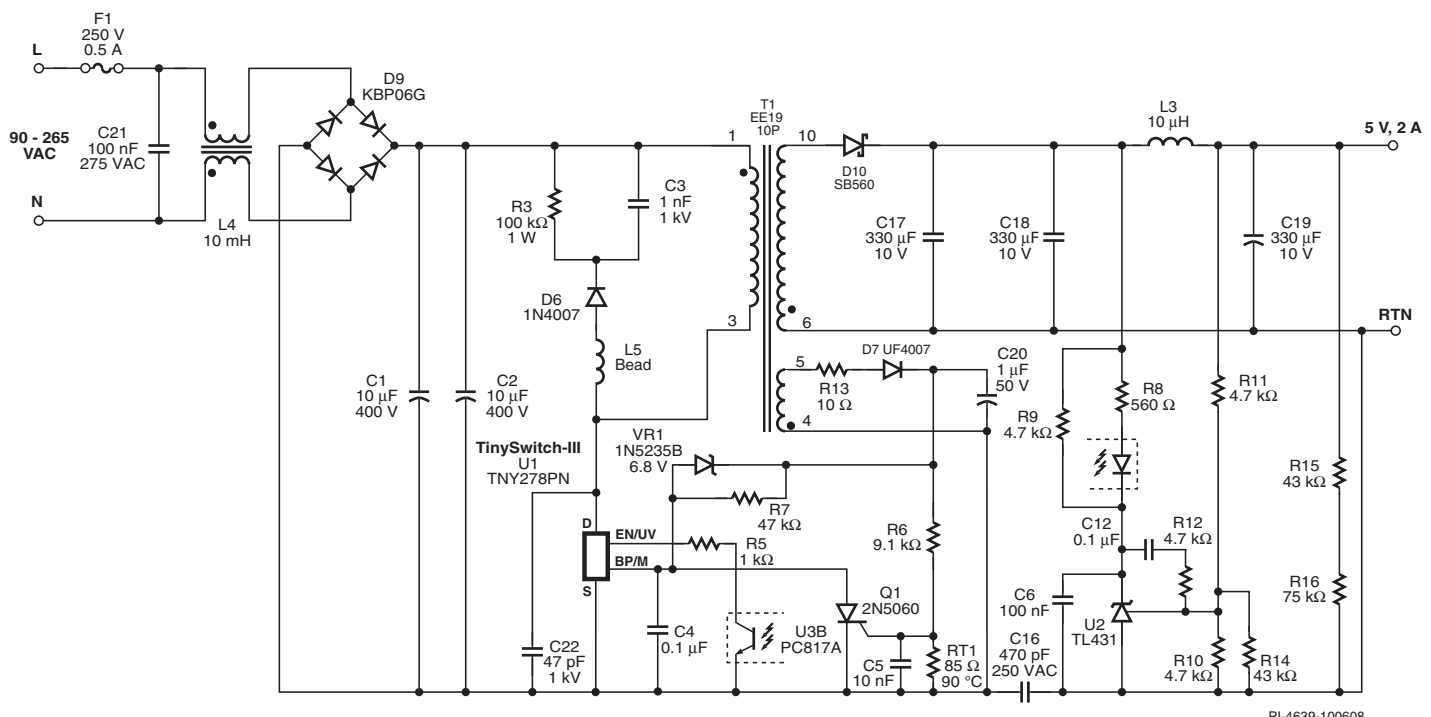


Figure 1. Schematic of 10 W Adapter Using a TNY278PN.

PI-4639-100608

resistance, of RT1 increases, the voltage at the gate of Q1 rises. Once the gate voltage and current thresholds are exceeded, Q1 conducts, pulling down the BP pin of U1 and disabling switching. The holding current for Q1 is provided via the internal current source of U1 that normally charges C4 during startup. To reset, the AC input must be removed such that current through Q1 falls below the specified holding current.

### Key Design Points

- Selecting a fast diode vs an ultra-fast diode for D6 will improve efficiency by recovering leakage inductance energy. If glass passivated (1N4007GP) is unavailable, a FR107 may be used.
- To prevent an increase in no-load consumption or false OVP triggering, VR1 should be selected to conduct only when the output voltage is outside the normal regulation range.
- Select a low gate current and low holding current device for Q1.
- The selectable current limit of U1 allows the current limit and device size to be optimized for the thermal environment. For example, in open frame applications, the TNY277PN part could be used by changing C4 from 0.1  $\mu$ F to 10  $\mu$ F.

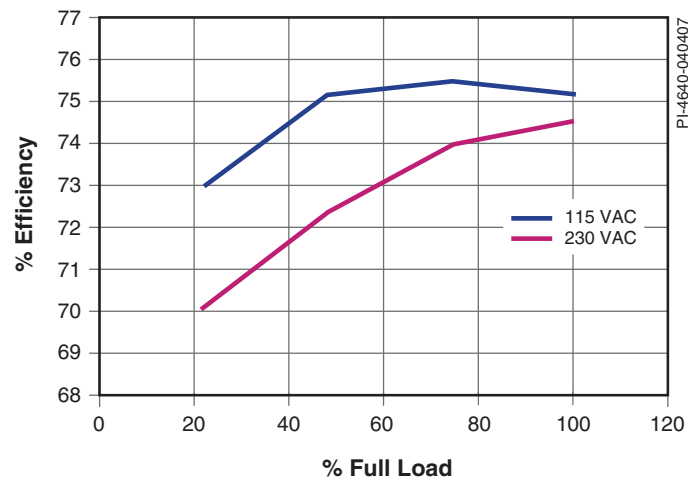


Figure 2. Efficiency vs. Line Voltage.

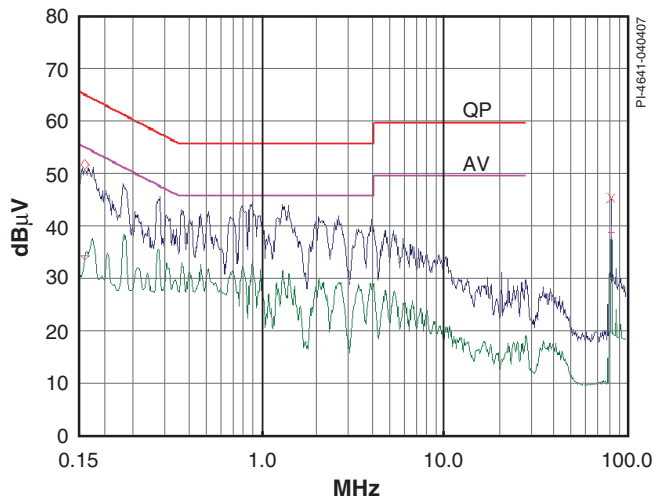


Figure 3. Worst Case Conducted EMI. Region Above 30 MHz Indicates Good Radiated EMI Performance. (Measured at 230 VAC, Output RTN Connected to Artificial Hand Input of LISN)

### Transformer Parameters

<b>Core Material</b>	EE19 NC-2H or equivalent, gapped for ALG of 200 nH/t <sup>2</sup>
<b>Bobbin</b>	EE19, 10 pin, Vertical
<b>Winding Details</b>	Shield: 23T X1, 0.25 mm, tape Primary: 57T, 0.3 mm, 2 layers, tape Shield: 23T X1, 0.23 mm Secondary: 5T, X2, 0.4 mm T.I.W. Bias: 11T, 0.25 mm
<b>Winding Order</b>	Shield (1-NC), Primary (1-3), Shield (4-NC), Secondary (6-10), Bias (4-5)
<b>Primary Inductance</b>	660 $\mu$ H, $\pm$ 7%
<b>Primary Resonant Frequency</b>	800 kHz (minimum)
<b>Leakage Inductance</b>	30 $\mu$ H (maximum)

Table 1. Transformer Parameters. (T.I.W. = Triple Insulated Wire, NC = No Connection)

Power Integrations  
5245 Hellyer Avenue  
San Jose, CA 95138, USA.  
Main: +1 408-414-9200  
Customer Service  
Phone: +1-408-414-9665  
Fax: +1-408-414-9765  
Email: usasales@powerint.com

On the Web  
www.powerint.com

Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS. The products and applications illustrated herein (transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at [www.powerint.com](http://www.powerint.com). Power Integrations grants its customers a license under certain patent rights as set forth at <http://www.powerint.com/ip.htm>.

The PI logo, TOPSwitch, TinySwitch, LinkSwitch, DPA-Switch, PeakSwitch, EcoSmart, Clampless, E-Shield, Filterfuse, StackFET, PI Expert and PI FACTS are trademarks of Power Integrations, Inc. Other trademarks are property of their respective companies. ©2007, Power Integrations, Inc.