Design Idea DI-63

TinySwitch®-II 4.8 W CV/CC Charger with Output Cable-Drop Compensation

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Charger	TNY266P	4.8 W	85-265 VAC	6 V, 800 mA ±7%	Flyback

Design Highlights

- Universal input, no-load consumption < 300 mW
- Meets CISPR-22 Class B EMI without a Y capacitor
- Extremely simple circuit, requires only 32 components!
- Circuit has output cable voltage drop compensation
- Ultra-low Leakage current: < 5 µA at 265 VAC input

Operation

Fusible resistor RF1 provides short-circuit fault protection and limits start-up inrush current. Inductors L1 and L2 and capacitors C1 and C2 form a low-cost pi (π) filter that attenuates conducted EMI.

Transformer (T1) has two shield windings (1-3 and 1-open) which reduce the generation of EMI noise. Winding phasing and D7 orientation let no secondary winding current flow when the MOSFET in U1 is ON, so primary winding current stores energy in the core of T1. When the MOSFET in U1 turns OFF, the energy stored in T1 drives current out of the secondary winding, forward biasing D7, charging C7 and developing/maintaining the output voltage across C7. The V_{BE} of Q1 and the V_Z of VR1 determine the CV set point. The voltage across R4, R5 and the U2-LED determine the CC set point.

Resistors R7, R10 and diode D6 compensate for output-cable voltage-drop. The CV portion of the output VI curve is flat, at the end of the cable, because a current sense resistor (R10) equal to the DC resistance of the output cable is in the voltage feedback loop. Diode D6 implements temperature compensation for the cable drop.

The combination of *TinySwitch-II* frequency jitter, the output diode snubber (R6 and C5), the T1 shield windings and careful primary clamp circuit component selection enable compliance with CISPR-22, Class B conducted EMI limits, without a Y-1 Safety capacitor. Eliminating the Y capacitor gives this circuit very low (< 5 µA) AC leakage current.

This circuit is suitable for portable electronics chargers.

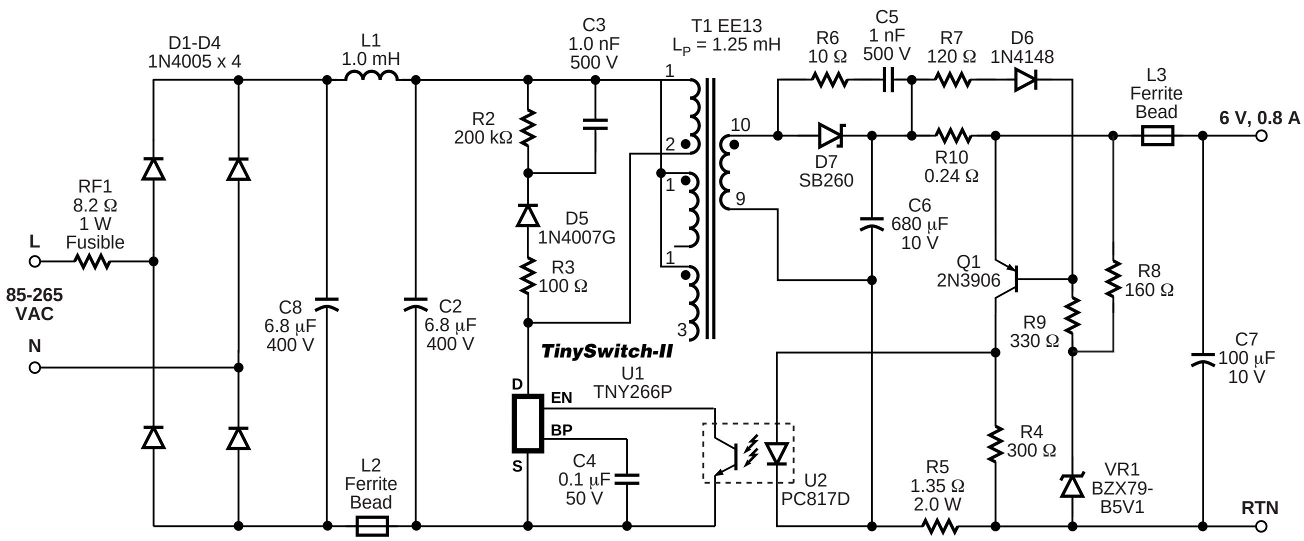

Figure 1. TinySwitch-II Based Charger/Adapter Circuit Diagram.

Key Design Points

- Secondary feedback bias current and output tolerances are minimized by using a low current part for VR1
- Primary clamp losses are minimized by keeping the voltage reflected across the transformer (V_{OR}) low
- Picking wire sizes that fill each winding layer produce transformers with the lowest leakage inductance
- Putting the floating shield winding between the primary and secondary windings reduces EMI noise
- A high gain opto-coupler (CTR = 200-400) keeps the CC portion of the output curve more vertical
- R10 should equal the output cable resistance value

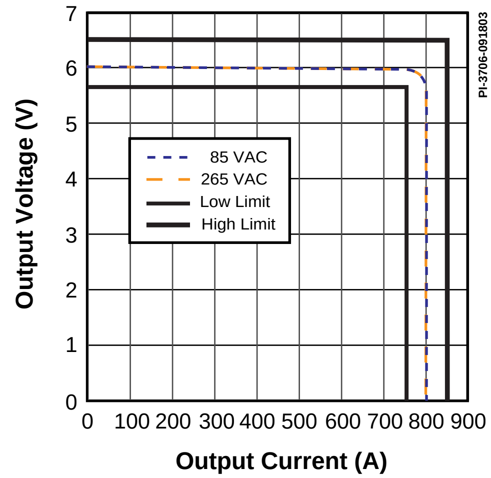

Figure 3. 6.0 VDC, 800 mA CV/CC Curve.

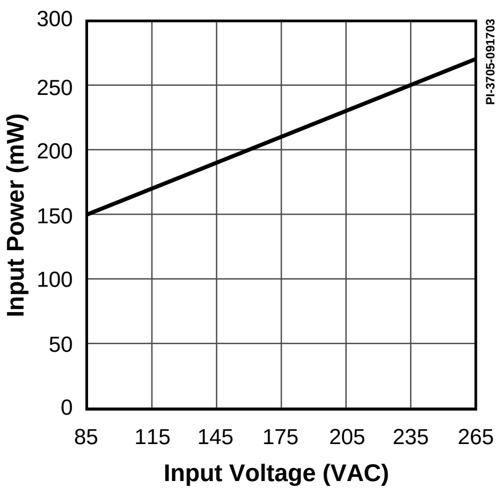

Figure 2. No-Load Input Power vs. Line Voltage.

TRANSFORMER PARAMETERS	
Core Material	EE16, TDK PC40, or equivalent A_L of 127.5 nH/T^2
Bobbin	EE16, 10 pin
Winding Order (pin numbers)	Core shield (1-3), tape Primary (1-2), tape Shield (1-floating), tape Secondary (10-9), tape
Primary Inductance	1.25 mH ±10%
Primary Resonant Frequency	500 kHz (minimum)
Leakage Inductance	35 µH (maximum)

Table 1. Transformer Construction Information.

WORLD HEADQUARTERS
Power Integrations, Inc.
San Jose, CA, USA
Phone: +1 408-414-9200

AMERICAS
Power Integrations, Inc.
Buford, GA, USA
Phone: +1 678-714-6033

CHINA (SHANGHAI)
Power Integrations Intl. Holdings, Inc.
Shanghai, China
Phone: +86-21-6215-5548

CHINA (SHENZHEN)
Power Integrations Intl. Holdings, Inc.
Shenzhen, China
Phone: +86-755-8367-5143

GERMANY
Power Integrations GmbH
Munich, Germany
Phone: +49-895-527-3910

INDIA (TECHNICAL SUPPORT)
Innovatech
Bangalore, India
Phone: +91-80-226-6023

ITALY
Power Integrations S.r.l.
Milano, Italy
Phone: +39-028-928-6001

JAPAN
Power Integrations, K.K.
Kanagawa, Japan
Phone: +81-45-471-1021

KOREA
Power Integrations Intl. Holdings, Inc.
Seoul, Korea
Phone: +82-2-782-2840

SINGAPORE (ASIA PACIFIC HQ)
Power Integrations Singapore Pte. Ltd.
Singapore
Phone: +65-6358-2160

TAIWAN
Power Integrations Intl. Holdings, Inc.
Taipei, Taiwan
Phone: +886-2-2727-1221

UK (EUROPE & AFRICA HQ)
Power Integrations (Europe) Ltd.
Bracknell, Berkshire, United Kingdom
Phone: +44-1344-462-300

APPLICATIONS HOTLINE
Phone: +1 408-414-9660
Fax: +1 408-414-9760

CUSTOMER SERVICE
Phone: +1 408-414-9665
Fax: +1 408-414-9765

For a complete list of our Worldwide Sales Representatives & Distributors visit our Web site: ***www.powerint.com***