Design Idea DI-59

LinkSwitch® Low Cost 2.5 W CV/CC Charger or Adapter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Charger/Adapter	LNK500	2.5 W	85-265 VAC	5.5 V	Flyback

Design Highlights

- Replaces a linear transformer based power supply at the same or lower cost, with better output regulation
- No-load input power consumption is less than 300 mW, at 230 VAC input: meets worldwide conservation guidelines
- Extremely simple circuit – requires only 23 components!
- No alternate path of secondary-side feedback is required: output feedback is obtained through the main transformer!
- Output Voltage (CV) tolerance ±10% at peak power point
- Output Current (CC) tolerance ±25%, when L ≤ ±10%
- Features the following auto-recovering protection functions: output short-circuit, open feedback loop, thermal shutdown
- Typically about 68% efficient!
- Meets EN550022 B EMI limits, without a Y-1 type Safety capacitor between the primary and the secondary
- Ultra-low leakage current: < 5 µA at 265 VAC input

Operation

Fusible resistor RF1 gives short-circuit fault protection and limits start-up inrush current. Diodes D1–D4 provide full bridge rectification that charges capacitors C1 and C2. Inductors L1 and L2 and capacitors C1 and C2 form a low-cost pi (π) filter that attenuates conducted EMI. Transformer (T1) winding phasing and D6 orientation let no secondary winding current flow when the MOSFET in U1 is ON, so the current that flows through the primary winding stores its energy in the core of T1. When the MOSFET in U1 is turned OFF, the energy stored in T1 drives current out of the secondary winding, forward biasing D6, charging C6 and developing/maintaining the output voltage across C6.

The RCD network of C3, D5 and R1 has two functions:
1) It clamps the reflection of the output voltage (V_{OR}) on the primary winding, as the MOSFET turns OFF.
2) It holds V_{OR}, for use as output feedback, eliminating the cost and complexity of a separate feedback path.

Resistor R1 attenuates the switching noise from the V_{OR}. Resistor R2 determines the amount of feedback current that flows into the CONTROL pin of U1. The output voltage can be fine-tuned by varying the value of R2. CONTROL pin capacitor C4 stores power and supplies it back to U1 during start-up, determines the restart "attempt" frequency in the auto-restart mode, shunts high frequency noise around U1 and provide U1 with the instantaneous MOSFET gate-drive current it requires. Resistor R3, capacitor C5, the 22-turn core cancellation winding and the 5-turn shield winding all reduce EMI.

LinkSwitch based solutions are designed to operate only in the discontinuous conduction mode. $P_O \approx 0.5\ L\ I^2 f$, where P_O = Output Power, L = transformer primary inductance, I = *LinkSwitch* peak current, f = Switching frequency and η = Efficiency. $I^2 f$ is accurately controlled for the *LinkSwitch*; therefore, P_O is proportional to L.

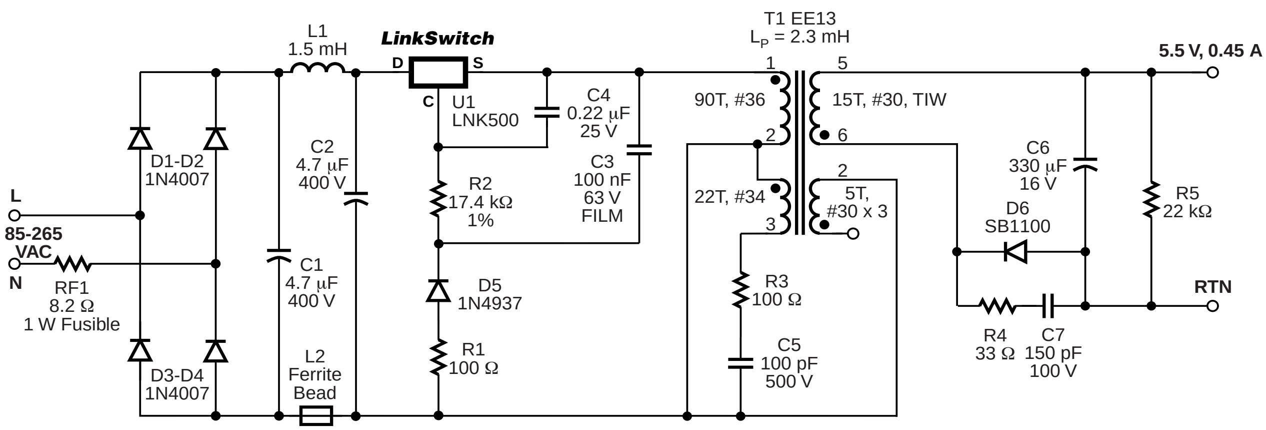

Figure 1. 2.5 W LinkSwitch Based Charger/Adapter

Typical applications are chargers for cell phones, PDAs, portable audio devices and shavers or power sources embedded within home appliances and consumer electronics, such as TV standby and bias supplies.

Key Design Points

- Set V_{OR} between 36 V and 60 V (50 V is optimum)
- Transformer primary inductance tolerance must be ≤10%, to maintain CC limit tolerance of ±25%
- If battery (load) voltage is less than 2 V, then the *LinkSwitch* will not come out of its auto-restart mode
- To increase the time period allowed for regulation to be reached at startup (or into a full-power resistive load), C4 must be increased in value to 1 μF
- To lower the ripple voltage into non-battery loads, an LC filter or LDO must be added onto the output

TRANSFORMER PARAMETERS	
Core	TDK PC40 EE13, A_L = 284 nH/T^2
Bobbin	EE13 Horizontal 8 pin
Winding Details	Core Cancellation: 22T, 34 AWG Primary: 90T, 36 AWG Shield: 5T, 3 x 30 AWG Secondary: 5T, 2 x 30 AWG (TIW) + 10T, 30 AWG (TIW)
Winding Order (pin numbers)	Core cancellation (2-3, clockwise), tape, Primary (1-2, clockwise), tape, Shield (2-open, anti-clockwise), tape, Secondary (5T: 5-7, anti-clockwise, 10T: 7-6, anti-clockwise)
Primary Inductance	2.3 mH ± 10%
Primary Resonant Frequency	300 kHz (minimum)

Table 1. Transformer Design Parameters.

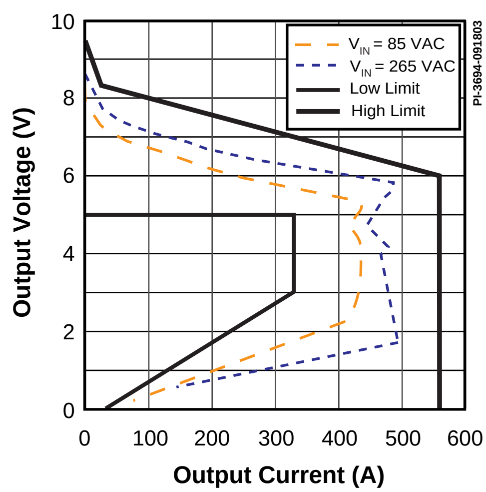

Figure 2. Load Regulation - CV/CC Characteristics.

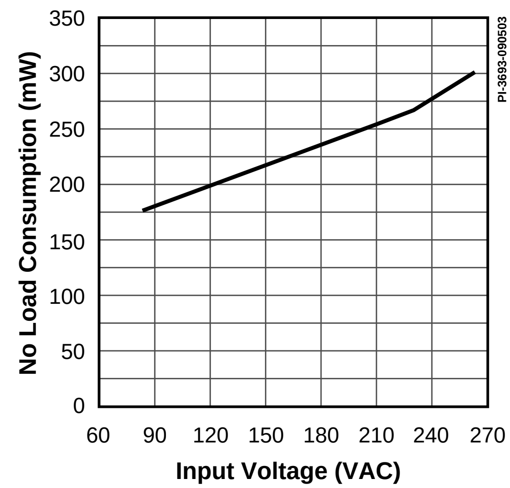

Figure 3. No-load Input Power Consumption.

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

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

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

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

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

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

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

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

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

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

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

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

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