

Design Idea DI-40

DPA-Switch™ 2.5 V, 20 W DC-DC Converter with Synchronous Rectification



Application	Device	Power Output	Input Voltage	Output Voltage	Topology
DC-DC Converter	DPA424R	20 W	36-75 VDC	2.5 V	Forward

Design Highlights

- Extremely low component count
- High efficiency - 86% using synchronous rectification
- No current sense resistor or current transformer required
- Output overload, open loop and thermal protection
- Accurate input under/overvoltage meets ETSI standards
- 300 kHz switching frequency - optimizes efficiency when simple self-driven synchronous rectification is used

Operation

DPA-Switch greatly simplifies the design compared to a discrete implementation. Resistor R1 programs the input UV/OV thresholds. The tight tolerance of the UV/OV thresholds limits the range of gate drive voltages applied to MOSFETs Q1 and Q2, eliminating the need for gate voltage clamp circuitry. The self-driven synchronous rectification configuration is therefore very simple, with R13 filtering voltage spikes at the gate of Q2, and D3 preventing the body diode of Q1 from conducting.

Capacitor C8 and the gate capacitance of Q1 reset T1 during *DPA-Switch* off-time. Zener VR1 provides a hard voltage clamp to limit DRAIN voltage under output transient and overload conditions.

Since the output voltage is low, the U2 LED is supplied with a higher voltage derived from a winding on output choke L2.

The *DPA-Switch* bias supply is derived from a forward winding on transformer T1. Flyback windings are not recommended for this purpose, since the bias capacitor C4 would create high capacitive loading during *DPA-Switch* off-time, preventing the transformer from efficiently resetting.

Key Design Points

- For nominal under-voltage set point V_{UV} : $R1 = (V_{UV} - 2.35 \text{ V}) / 50 \mu\text{A}$. $V_{OV} = (R1 \times 135 \mu\text{A}) + 2.5 \text{ V}$.
- Locate C5, C6, and R4 close to U1 CONTROL pin, with ground connected to SOURCE pin.
- Minimize primary and secondary layout loop area to reduce parasitic inductance.

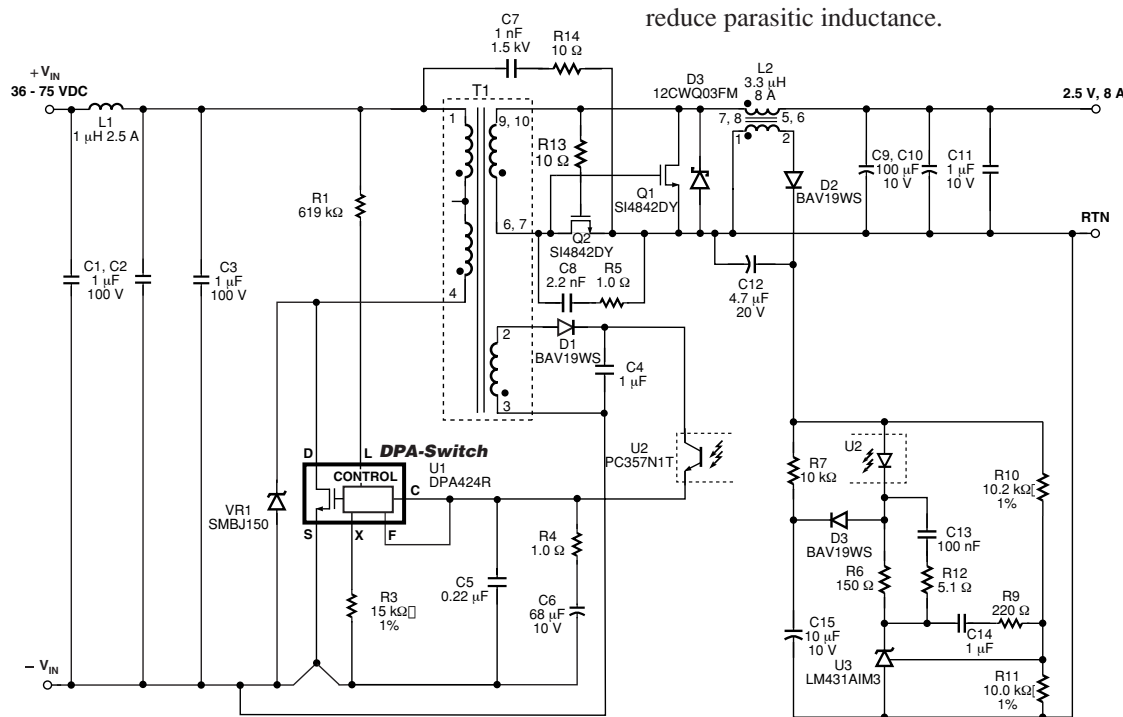


Figure 1. *DPA-Switch* 20 W DC to DC Converter.

PI-3264-091702

- Optocoupler U2 should have controlled CTR of 100-200% for optimum loop stability.
- Size transformer reset components C8 and R5, and the Q1 gate capacitance to assure transformer reset at minimum operating voltage without exceeding 170 V drain voltage at high line.
- Set Zener VR1 clamp voltage to 150 V to guarantee both transformer reset and limit DRAIN voltage below BV_{DSS} .
- Scale primary side forward bias winding to provide 12 V to 15 V at minimum input voltage, nominal load.
- Secondary choke winding provides 5 V at nominal load.
- Main primary power return should be connected to the *DPA-Switch* tab, not to the SOURCE pin.
- Consult AN-31 for additional design tips.

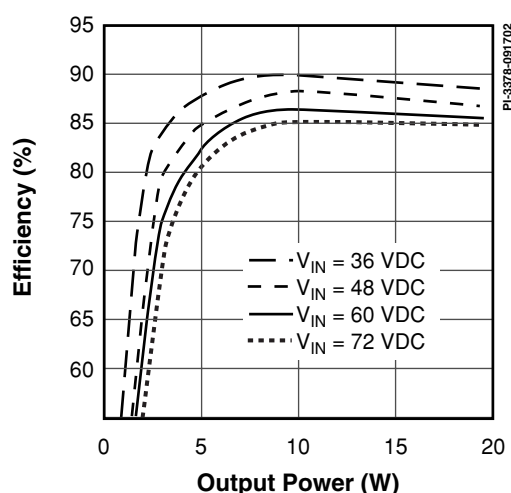


Figure 2. Efficiency vs. Output Power.

TRANSFORMER PARAMETERS

Core Material	PR1408 EPCOS N87 material ungapped
Bobbin	P1408 8 pin (B&B B-096 or equivalent)
Turns	Bias: 6T, 32 AWG Primary: 7T + 7T, 2 x 28 AWG Secondary: 2T, 4 x 26 AWG
Winding Order (Pin Numbers)	Bias: (3-2), Tape Primary: (4-FL), Tape Secondary: (6, 7-9, 10), Tape Primary: (FL-10), Tape
Primary Inductance	392 μ H \pm 25%
Primary Resonant Frequency	3 MHz (minimum)
Leakage Inductance	1 μ H (maximum)

Table 1. Transformer Construction Information.

OUTPUT INDUCTOR PARAMETERS

Core	EPCOS N87 material Gap for A_L of 206 nH/T ²
Bobbin	P1408 8 pin (B&B B-096 or equivalent)
Winding Details	Bias: 10T, 32 AWG Main: 4T, 4 x 26 AWG
Winding Order (Pin Numbers)	Bias: (1-2), Tape Main: (7,8-5,6), Tape
Inductance Pins 5,6-7,8	3.3 μ H \pm 10%

Table 2. Output Inductor Construction Information.

For the latest updates, visit our Web site: 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, nor does it convey any license under its patent rights or the rights of others.

The products and applications illustrated herein 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.

The PI Logo, **TOPSwitch**, **TinySwitch** and **EcoSmart** are registered trademarks of Power Integrations, Inc. **PI Expert** is a trademark of Power Integrations Inc. ©Copyright 2002, Power Integrations, Inc.

WORLD HEADQUARTERS AMERICAS

Power Integrations, Inc.
San Jose, CA 95138 USA
Customer Service:
Phone: +1 408-414-9665
Fax: +1 408-414-9765
e-mail: usasales@powerint.com

CHINA

Power Integrations International
Holdings, Inc.
China
Phone: +86-755-8367-5143
Fax: +86-755-8377-9610
e-mail: chinasales@powerint.com

EUROPE & AFRICA

Power Integrations (Europe) Ltd.
United Kingdom
Phone: +44-1344-462-300
Fax: +44-1344-311-732
e-mail: eurosales@powerint.com

KOREA

Power Integrations
International Holdings, Inc.
Seoul, Korea
Phone: +82-2-782-2840
Fax: +82-2-782-4427
e-mail: koreasales@powerint.com

SINGAPORE

Power Integrations, Singapore
Republic of Singapore 308900
Phone: +65-6358-2160
Fax: +65-6358-2015
e-mail: singaporesales@powerint.com

JAPAN

Power Integrations, K.K.
Keihin-Tatemono 1st Bldg.
Japan
Phone: +81-45-471-1021
Fax: +81-45-471-3717
e-mail: japansales@powerint.com

APPLICATIONS HOTLINE

World Wide +1-408-414-9660

TAIWAN

Power Integrations
International Holdings, Inc.
Taipei, Taiwan
Phone: +886-2-2727-1221
Fax: +886-2-2727-1223
e-mail: taiwansales@powerint.com

INDIA (Technical Support)

Innovatech
Bangalore, India
Phone: +91-80-226-6023
Fax: +91-80-228-9727
e-mail: indiasales@powerint.com

APPLICATIONS FAX

World Wide +1-408-414-9760