

Design Idea DI-31

DPA-Switch™ 5 V, 70 W DC-DC

Converter with Synchronous Rectification



Application	Device	Power Output	Input Voltage	Output Voltage	Topology
DC-DC Converter	DPA426R	70 W	36-75 VDC	5 V	Forward

Design Highlights

- Extremely low component count
- High efficiency, 90% 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 using simple self-driven synchronous rectification

Operation

The 70 W converter shown in Figure 1 benefits from many of the *DPA-Switch* integrated features. In particular, no external current sense components are required. In a discrete implementation, an expensive current transformer and a number of additional components would increase the cost of this converter significantly.

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 to Q6, eliminating the need for gate voltage clamp circuitry. The self-driven synchronous rectification configuration is therefore very simple, with R4 to R6 filtering voltage spikes at the gates of Q1, Q2 and Q3 and D4 preventing the body diodes of Q4, Q5 and Q6 from conducting.

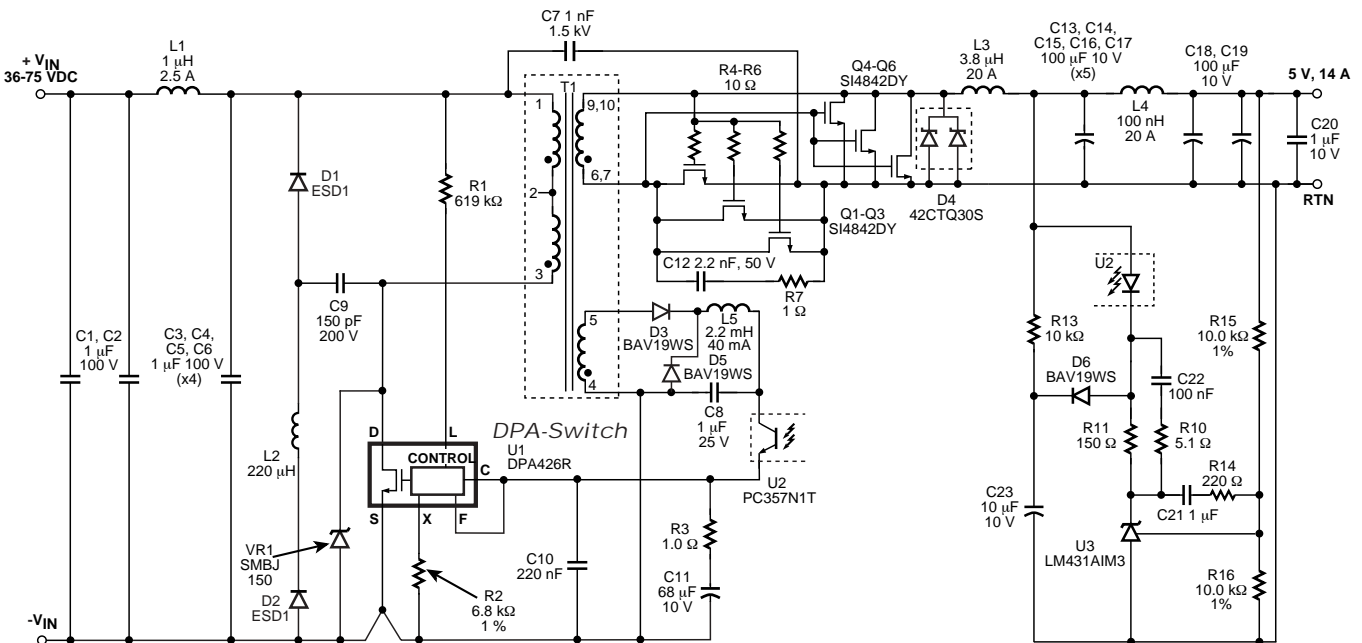
Capacitor C9, diodes D1-D2, and inductor L2 form a resonant snubber that recycles leakage and magnetizing energy stored in T1, and also helps to reset T1. Zener diode VR1 provides a hard voltage limit and only conducts during output transient and overload conditions. Capacitor C12 and Resistor R7 damp secondary switching spikes and help to reset T1.

Key Design Points

- For nominal undervoltage 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 C10, C11, and R3 close to the U1 CONTROL pin, with ground connections returned to SOURCE pin.



PI-3375-121602

Figure 1. DPA426 70 W, 5 V, 14 A DC-DC Converter.

- Minimize primary and secondary high current loop areas to reduce parasitic inductance.
- Optocoupler U2 should have a controlled CTR range of 100 to 200% for optimum loop stability.
- Size transformer reset components to ensure transformer reset at minimum operating voltage without exceeding 170 V drain voltage at high line. It may be necessary to gap T1 to offset effect of Q4-Q6 gate capacitance.
- Set Zener VR1 clamp voltage to 150 V to both safely limit the DRAIN below BV_{DSS} and guarantee transformer reset.
- Select number of bias turns to provide 12 V to 14 V at minimum input voltage and full load.
- Main primary power return should be connected to the *DPA-Switch* tab, not to the SOURCE pin.
- Scale time constant of C9 and L2 to allow C9 to reset completely during minimum on-time conditions.
- Consult AN-31 for additional design tips and information.

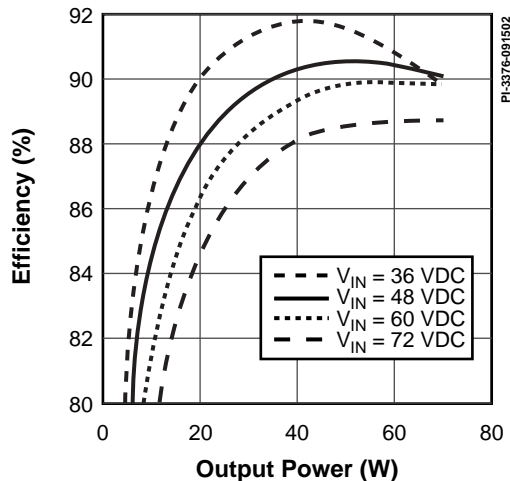


Figure 2. Efficiency vs. Output Power.

TRANSFORMER PARAMETERS	
Core Material	EFD25, 3F3 Gap for $A_{LG} = 1100 \text{ nH/T}^2$
Bobbin	EFD25 10 pin (B&B B-025 or equivalent)
Winding Details	Bias: 5T, 30 AWG Primary: 6T+ 5T, 4 x 26 AWG Secondary: 3T, 0.005" Cu foil
Winding Order (Pin Numbers)	Primary (3-2), tape, Bias (4-5), tape, Secondary (6,7-9,10), tape, Primary (2-1), tape
Inductance	Primary: 130 $\mu\text{H} \pm 10\%$, Leakage: 10 μH (max)
Primary Resonant Frequency	3 MHz (minimum)

Table 1. Transformer Design Parameters.

OUTPUT INDUCTOR PARAMETERS	
Core	EE22, TDK PC40 Material Gap for A_{LG} of 250 nH/T^2
Bobbin	TDK BE-22-5116
Winding Details	4T, 0.016" Cu foil
Inductance	4 $\mu\text{H} \pm 10\%$

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*, *LinkSwitch* 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

