DI-24 Design Idea
DPA-Switch®

30 W DC-DC Converter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
DC-DC Converter	DPA424R	30 W	36 – 75 VDC	5 V	Forward

Design Highlights

- Extremely low component count
- High efficiency – 85% using Schottky rectifiers
- No current sense resistor or current transformer required
- Output overload, open loop and thermal protection
- Accurate input under/over voltage meets ETSI standards
- Operates to zero load
- 400 kHz operation minimizes size of magnetics
- Available for prototyping in DAK-21

Operation

DPA-Switch greatly simplifies the design compared to a discrete implementation. Resistor R1 programs the input under/over voltages to 33 V and 86 V, respectively, and linearly reduces the maximum duty cycle with input voltage to prevent core saturation during load transients. These thresholds have tolerances that guarantee the converter is operational at 36 V, without the cost of additional line sense components.

Resistor R3 programs the internal DPA424R current limit to 85% of nominal, just above the level needed at full load, limiting overload power. This feature also allows a larger DPA-Switch to be selected, without requiring any other circuit changes. A larger DPA-Switch reduces conduction losses, raising efficiency. Capacitors C8 and C9 provide transformer core reset; C8 also limits the leakage inductance spike on the DRAIN. Resistor R5 in series with C9 damps ringing. Zener diode VR1 provides a hard voltage clamp to limit DRAIN voltage, but is only active during transients and overload conditions.

The bias supply for U1 is provided from an auxiliary winding on output inductor L2. This gives higher efficiency than a transformer winding, since it provides a fixed voltage independent of input voltage. Pre-load R13 maintains the bias voltage ≥8 V at zero load.

On the secondary, a soft finish network, C13, D3 and R7, eliminates output turn-on overshoot. The remaining components provide output voltage regulation and loop compensation.

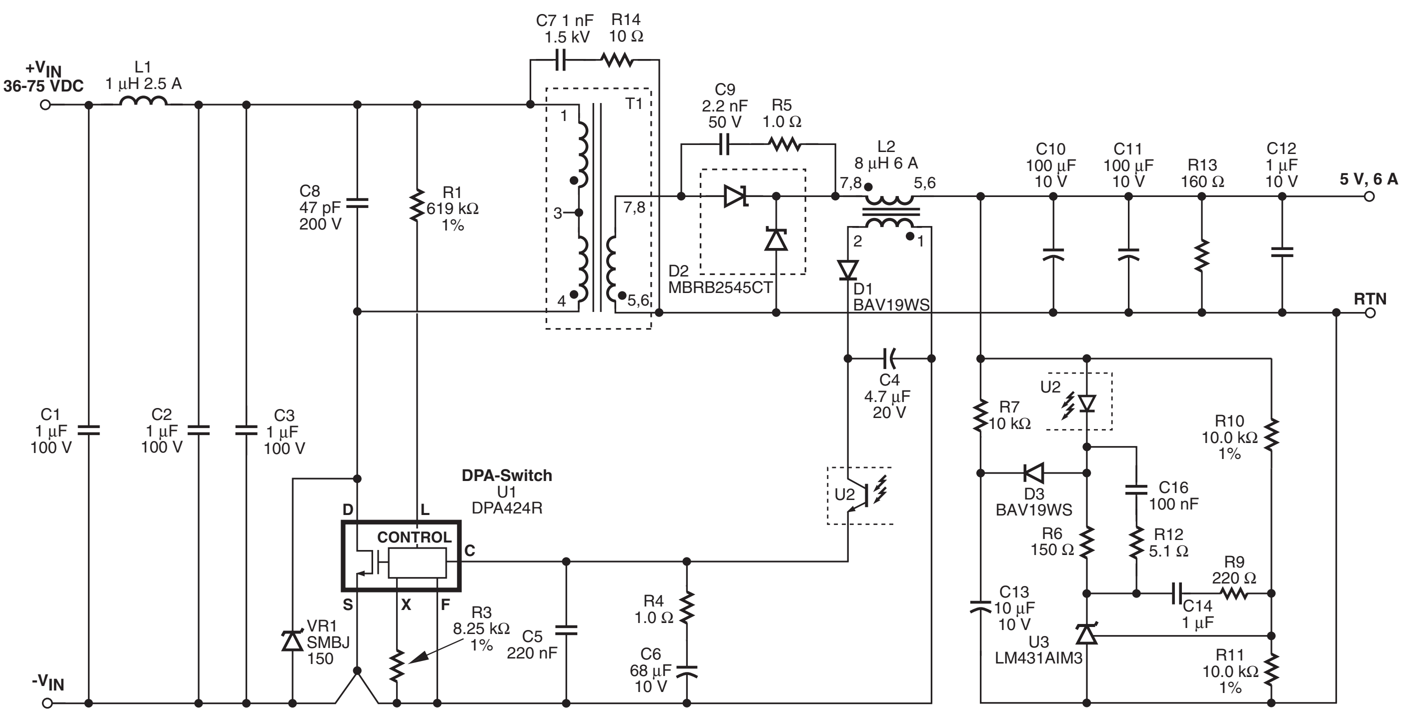

Figure 1. DPA-Switch 30 W DC-DC Converter.

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Key Design Points

- For nominal under-voltage set point VUV: R1 = (V_{UV}-2.35 V)/50 µA. V_{OV} = (R1 × 135 µA) + 2.5 V.
- Select C9 such that the core resets at V_{UV} and the DRAIN voltage ≤170 V at V_{OV}. To reduce leakage spike, C8 may be added, adjusting C9 accordingly.
- Zener VR1 safely limits the DRAIN voltage below BV_{DSS} and guarantees transformer reset.
- Opto U2 should have a CTR of between 100% and 200% for optimum loop stability.
- At zero load, maximum input voltage, the bias voltage across C4 should be ≥8 V (12 V to 15 V under nominal conditions).
- Good layout practices should be followed:
  - Locate C5, C6 and R4 close to U1, with grounds returned to the SOURCE pin.
  - Primary return should be connected to the DPA-Switch tab, not the SOURCE pin.
  - Minimize the primary and secondary loop areas to reduce parasitic leakage inductance.
- Consult AN-31 and EPR-21 for additional design tips and information.

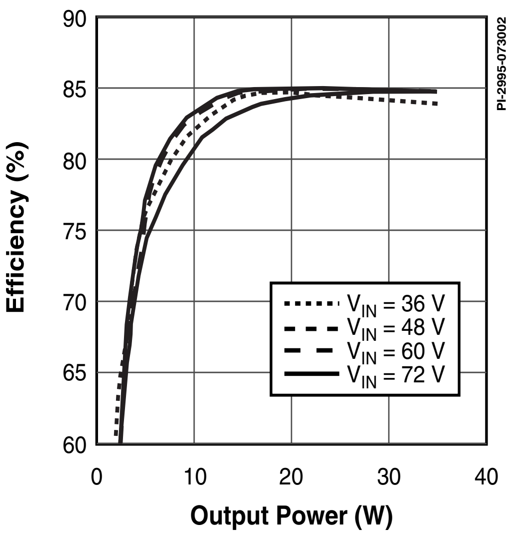

Figure 2. Efficiency vs. Output Power.

Transformer Parameters

Core Material	PR1408 Siemens N87 material, ungapper
Bobbin	P1408 8 pin (B&B B-096 or equivalent)
Winding Details	Primary: 7T + 8T, 27 AWG Secondary: 4T × 27 AWG
Winding Order (pin numbers)	Primary: (4–3), tape Secondary: (5,6–7,8), tape Primary: (3–1), tape
Primary Inductance	Primary : 450 µH, ±25% Leakage: 1 µH (maximum)
Primary Resonant Frequency	3.8 MHz (minimum)

Table 1. Transformer Construction Information.

Output Inductor Parameters

Core Material	PR1408 Siemens N87 material Gap for A_L of 163 nH/T^2
Bobbin	P1408 8 pin (B&B B-096 or equivalent)
Winding Details	Bias: 18T, 32 AWG Main: 7T, 2 × 24 AWG
Winding Order (pin numbers)	Bias (1–2), tape, Main winding (7,8–5,6), tape
Primary Inductance Pins 5,6–7,8	8 µH, ±10%

Table 2. Output Inductor Construction Information.

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