DI-23 Design Idea
TOPSwitch®-GX

10 W, Multi-output, High Speed Modem Power Supply

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
High Speed Modem	TOP243PN	10 W	85 – 265 VAC	3.3 V / 5 V / 30 V	Flyback

Design Highlights

- Compact low cost design (113 mm × 39 mm × 25 mm) with only 46 parts
- Meets Blue Angel no-load power consumption
- Line undervoltage protection prevents turn-off output glitches and overvoltage protection provides extended line surge protection
- Hysteretic thermal shutdown provides automatic fault recovery
- Frequency jittering dramatically reduces EMI and meets EN550022 Class B without Y1 capacitor
- Ultra low leakage current (<1 μA at 265 VAC) eliminates audio hum in voice applications
- Surge immunity to 4 kV (EN61000-4-5)
- High efficiency >70%

Operation

TOP243PN (DIP package) is shown in Figure 1. The power supply utilizes many TOPSwitch-GX features such as frequency jittering, input voltage sense, thermal shutdown, internal current limit, soft-start, etc. without adding any extra components.

Typical applications are wall mount adapters, set-top box, high-speed modem, standby power supplies, and other applications requiring very low cost, small size, and low no-load input power consumption.

The example discussed here passes EMI conducted and radiated emissions tests without using a Y1 capacitor between primary and secondary. This is possible with the frequency jittering feature of TOPSwitch-GX and careful transformer construction. Shield windings are used in the transformer to reduce common mode EMI currents. Transformer specifications are given in Table 1.

Good cross-regulation of output voltages is achieved by careful transformer construction and using a TL431 voltage regulator instead of a Zener regulator.

The power supply uses a low cost RCD clamp with a slow 1N4007GP diode, which reduces EMI emissions and recycles leakage energy, increasing efficiency. Input line sensing prevents reverse conduction of current in TOPSwitch-GX at very low input voltages due to the 1N4007GP in the RCD clamp.

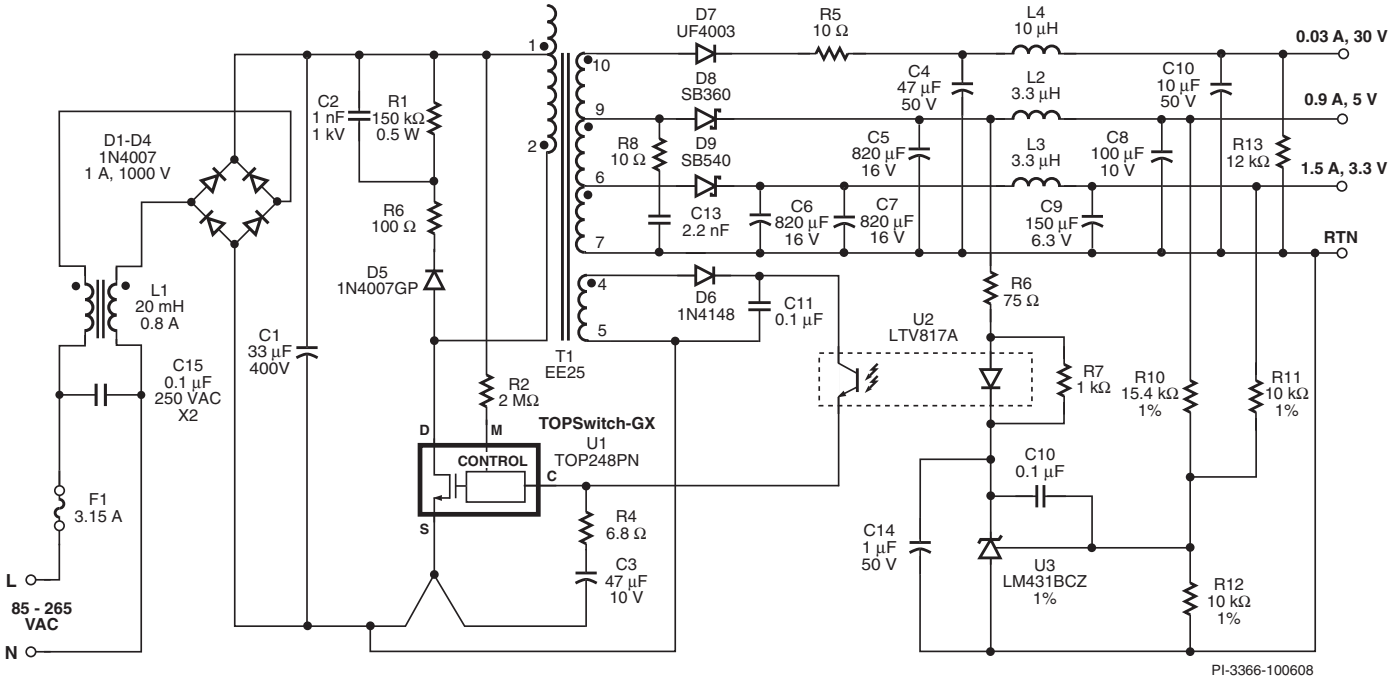

Figure 1. 10 W, 3.3 V at 1.5 A, 5 V at 0.9 A, 30 V at 0.03 A, High Speed Modem Power Supply Using TOP243PN.

Key Design Points

- Use K_{RP} (Ripple-to-peak current ratio) in the range of 0.4–0.6 for better efficiency.
- Select V_{OR} (reflected output voltage) of 90 V to 110 V for optimum performance.
- Opto with CTR range of 80% to 160% recommended.
- PCB traces which carry high switching voltages and current should be short and wide to reduce EMI.
- Reduce leakage inductance and improve cross-regulation by filling each winding layer across the entire width of the bobbin.
- Use shield windings to improve EMI.
- Use a layer of insulation tape between layers of primary winding to reduce inter-winding capacitance.
- D5 should be a GP type (glass passivated) to ensure a controlled reverse recovery time.

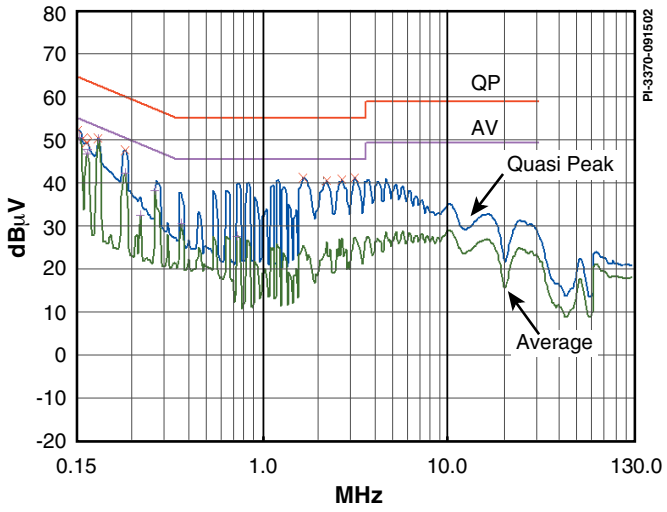

Figure 2. Conducted Emissions – EN55022 Class B (QP and AV), 230 VAC, Full Load, Artificial Hand Connected to Secondary Return.

V_o	Load Range (Amp)	Regulation (%)																		
		-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
3.3	0.3-1.5																			
5	0.3-0.9																			
30	0.01-0.03																			

Table 2. Worst Case Output Cross-Regulation - All Outputs Taken from Minimum to Maximum Load.

Transformer Parameters	
Core Material	EE26, Nippon Ceramic NC-2H or equivalent, ALG = 351 nH/t²
Bobbin	YW-360-02B, YIH-HWA, 10 pin Vertical
Winding Details	Shield: 15T, 2 × 29 AWG Primary: 49T, 27 AWG Bias: 7T, 3 × 28 AWG 3.3 V: 2T, 3 × 25 AWG T.I.W. 5 V: 1T, 26 AWG T.I.W. 30 V: 13T, 26 AWG T.I.W.
Winding Order	Shield (1–NC), 3 × tape, Primary (2–1), with tape between layers, tape, Bias (6–4), 6 × tape, 3.3 V (6–7), tape, 5 V (9–6), tape, 30 V (10–9), 2 × tape, Shield (1–3), 3 × tape
Inductance	Primary: 1 mH, ±10% Leakage: 30 µH (maximum)
Primary Resonant Frequency	500 kHz (minimum)

Table 1. Transformer Parameters. (AWG = American Wire Gauge, T.I.W. = Triple Insulated Wire)

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