

# DI-39 Design Idea

## TOPSwitch®-GX

### 13 W, Universal Input DVD Supply with 70 mW No-load

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
DVD	TOP244PN	13 W cont, 17 W pk	85 – 265 VAC	3.3 V, 5 V, 12 V, -12 V	Flyback

#### Design Highlights

- High efficiency multi-output flyback (77% minimum)
- Topology scalable to higher powers
- Excellent cross-regulation
- Excellent input no-load consumption <70 mW input
- 132 kHz switching frequency allows smaller transformer
- Frequency jitter eliminates common-mode EMI choke
- >10 dB margin against CISPR22-B conducted EMI with artificial hand grounding

#### Operation

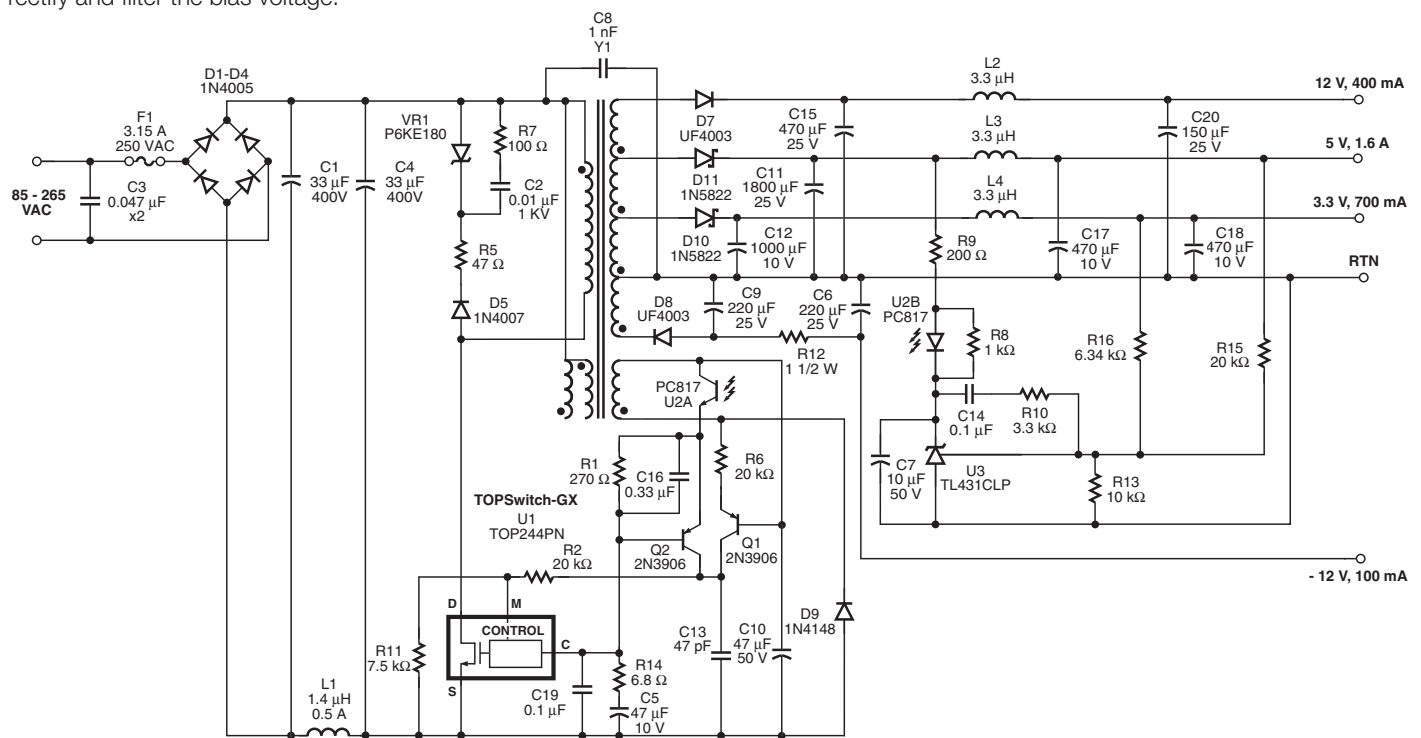
The TOPSwitch-GX uses current mode feedback to achieve excellent no-load standby. Components C16, R1 and Q2 provide a constant current powering the TOPSwitch-GX CONTROL pin. Resistor R2 feeds the remainder of Q2 current to the M pin, reducing TOPSwitch-GX current limit with increased current.

Resistor R11 sets the maximum current limit of the device. Components R6, Q1 and C13 implement slope compensation. The supply operates at full frequency at high and medium power and reduces frequency at light loads. Components D9 and C10 rectify and filter the bias voltage.

TOPSwitch-GX frequency jitter allows conducted EMI compliance without a common-mode choke, using only capacitors C1, C4 and inductor L1 as an EMI filter.

Components D5 and C2 form a capacitor clamp circuit absorbing leakage inductance energy during normal operation. Zener VR1 clamps the voltage to a safe level during abnormal and transient conditions. After clamping, reverse current flows through D5, recovering some of the energy. Resistor R5 limits the reverse current and, with R7, improves EMI by limiting the ringing on the drain. Continuous mode operation allows reduced primary and secondary peak currents, optimizing cross regulation and load regulation by minimizing leakage inductance induced voltage shifts.

Resistors R15 and R16 share the feedback from the 3.3 V and 5 V outputs for good cross-regulation.



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Figure 1. TOPSwitch-GX DVD Player Schematic.

## Key Design Points

- Use of foil for the 3.3 V and 5 V windings also helps to optimize cross-regulation.
- Optional capacitor C7 is the “soft-finish” capacitor and prevents overshoot on startup.
- Compact layout for components D7, D10, D11, C11, C12, C15 will improve cross-regulation and efficiency. Compact layout for L2, L3, L4, C17, C18, and C20 will achieve best output ripple.
- Figure 2 shows conducted EMI at 230 VAC full load, with output “Artificial Hand” grounding. Floating output return gives lower results.
- Table 2 shows the cross regulation of the supply over load for both 115 VAC and 230 VAC.

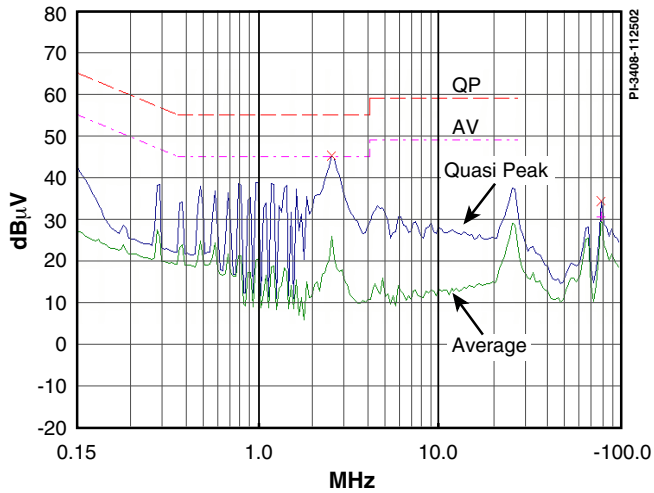


Figure 2. EMI at 230 VAC Full Load with “Artificial Hand” Grounding of Output.

## Transformer Parameters

<b>Core Material</b>	EEL25 Himag MZ4 EEL25.4, Taiwan ALG of 344 nH/t <sup>2</sup>
<b>Bobbin</b>	EEL25 14 pin, Vertical
<b>Winding Details</b>	Shield: 32T × 2 × 32 AWG Primary: 64T × 2 × 32 AWG Bias: 10T × 4 × 32 AWG Shield: 2T × 8 × 32 AWG +3.3 V: 4T × foil 0.052 × 14 mm +5 V: 1T × foil 0.052 × 14 mm +12 V: 4T × 4 × 32 AWG -12 V: 7T × 4 × 32 AWG
<b>Winding Order (pin numbers)</b>	Shield (NC–5), tape, Primary (1–4), tape, Bias (7–6), tape, Shield (5–NC), tape, +12 V (13–8), +3.3 V (11,12–9,10), +5 V (9–10,13), tape, -12 V (14–11,12), tape
<b>Primary Inductance (pins 1-4, all others open)</b>	1.42 mH, ±10% at 132 kHz
<b>Primary Resonant Frequency</b>	300 kHz (minimum)
<b>Leakage Inductance</b>	30 µH (maximum)

Table 1. Transformer Parameters. (AWG = American Wire Gauge, NC = No Connection)

Output Voltage (V)	Load Range (%)	Cross Regulation (%)								
		-4	-3	-2	-1	0	1	2	3	4
3.3	10-100									
5	10-100									
12	10-100									
-12	10-100									

Table 2. Worst Case Cross Regulation at 115 VAC and 230 VAC.

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