Design Idea DI-16

TOPSwitch®-GX 57 W, 230 VAC, Multi-output Set-top Box Power Supply

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Set-top Box	TOP246Y	43 W cont./57 W peak	180-265 VAC	3.3 V / 5 V / 12 V / 18 V / 33 V	Flyback

Design Highlights

- High efficiency, >75% at 180 VAC
- Good cross-regulation with no linear regulators
- Line undervoltage detection (UV) and overvoltage (OV) power system surge protection
- Meets CISPR22B/EN55022B conducted EMI limits
- Differential and common mode surge immunity to 4 kV (EN61000-4-5)
- 100 kHz ring wave immunity to 4 kV (IEEE C62.41)

Key Design Points

- R1 (2 MΩ, 0.5 W) sets UV at 100 VDC and OV at 450 VDC. A 0.5 W resistor is required to give a voltage rating greater than 350 VDC.
- Integrated OV shut-down protects against long duration line voltage surges (common in some countries). During shut-down, the drain voltage does not exceed the DC input voltage (drain does not switch), allowing the AC rail to rise to 495 VAC (700 VDC BV_{DSS} rating) without damaging the *TOPSwitch-GX*.
- Transformer T1 is constructed using a slotted bobbin, enabling automated transformer winding and assembly.
- The transformer turns ratio is optimized (including output diode forward drops) to minimize the output voltage error between the 3.3 V and 5 V outputs.
- Feedback is taken from both the 3.3 V and 5 V outputs to the reference (U3) via R10, R11 and R13. Other output voltages are set by the transformer turns ratio. The 12 V, 18 V, and 33 V outputs are DC-stacked on the 5 V output for enhanced regulation and voltage centering. Pre-load resistor R14 is required to maintain regulation of the 33 V output when lightly loaded.

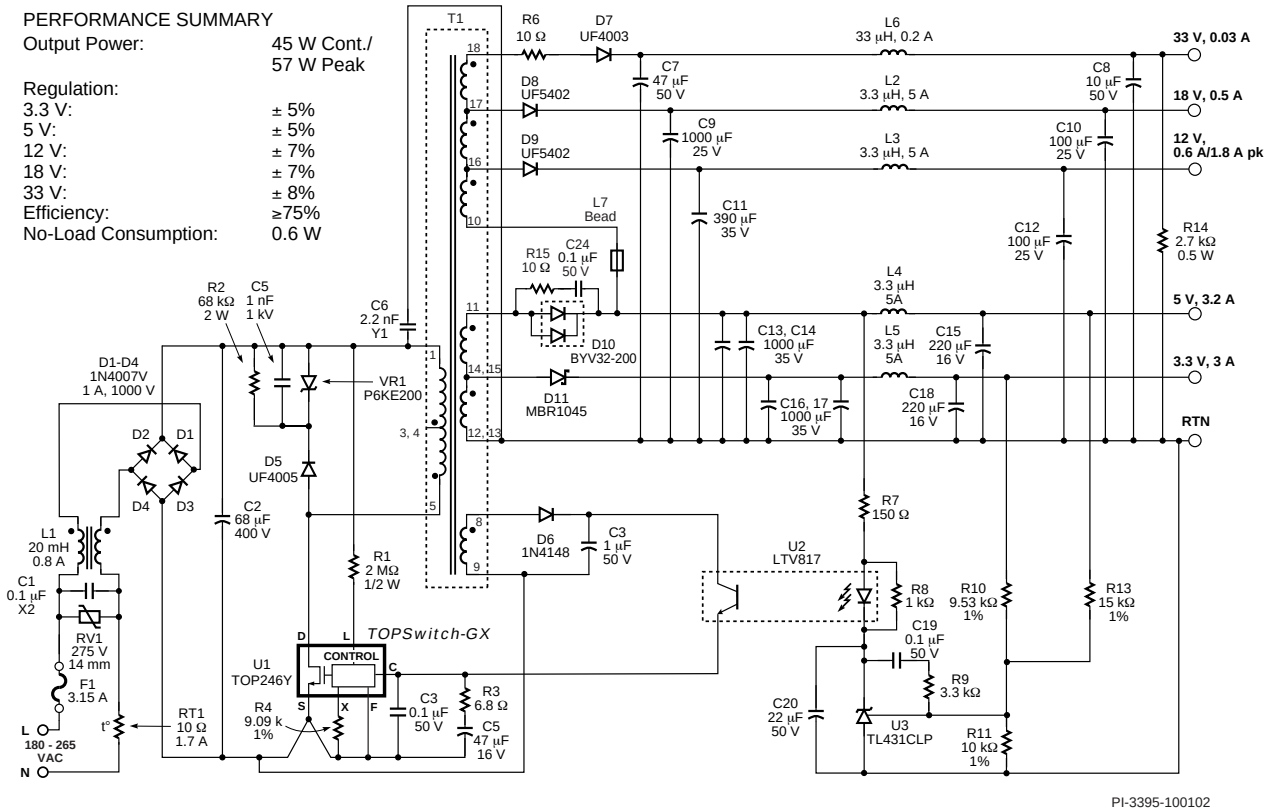

Figure 1. TOPSwitch-GX 60 W Set-top Box Output Power Supply.

- A soft-finish capacitor (C20), eliminates start-up output overshoot.
- Second stage LC post-filtering was used on all outputs for low output ripple (L2-6 and C8, 10, 12, 15 and 18).
- Primary clamp components VR1 and D5 limit the leakage inductance induced peak drain voltage to a safe value. R2 and C5 reduce power dissipation in VR1.
- Frequency jitter provides large EMI margins with simple filtering.

WINDING INSTRUCTIONS				
Slot 1 –	Start Pin 5	26T	0.25 mm	Finish Pin 3
Slot 2 –	Start Pin 11	1T	0.25 mm	Finish Pin 14
	Start Pin 14	2T	0.25 mm	Finish Pin 12
	Start Pin 16	4T	0.25 mm	Finish Pin 10
	Start Pin 17	3T	0.25 mm	Finish Pin 16
	Start Pin 18	6T	0.25 mm	Finish Pin 17
Slot 3 –	Start Pin 3	26T	0.25 mm	Finish Pin 1
	Start Pin 8	7T	0.25 mm	Finish Pin 9
Slot 4 –	Start Pin 11	1T	0.25 mm	Finish Pin 14
	Start Pin 14	2T	0.25 mm	Finish Pin 12
	Start Pin 14	2T	0.25 mm	Finish Pin 12
Slot 5 –	Start Pin 5	26T	0.25 mm	Finish Pin 4
Slot 6 –	Start Pin 11	1T	0.25mm	Finish Pin 15
	Start Pin 15	2T	0.25mm	Finish Pin 13
	Start Pin 15	2T	0.25 mm	Finish Pin 13
	Start Pin 16	4T	0.25 mm	Finish Pin 10
Slot 7 –	Start Pin 4	26T	0.25 mm	Finish Pin 1
Slot 8 –	Start Pin 11	1T	0.25 mm	Finish Pin 15
	Start Pin 15	2T	0.25 mm	Finish Pin 13
	Start Pin 16	4T	0.25 mm	Finish Pin 10
	Start Pin 17	3T	0.25 mm	Finish Pin 16
	Start Pin 18	6T	0.25 mm	Finish Pin 17
Slot 9 –	Start Pin 5	26T	0.25 mm	Finish Pin 4

Table 1. Transformer Build Information.

TRANSFORMER PARAMETERS	
Core & Bobbin	Orega SMT 18 core/bobbin set, gappped for 180 nH/T^2
Primary Inductance (pins 1-5, with pins 3-4 shorted together, all other windings open)	487 µH ±10%
Primary Resonant Frequency (same test conditions as above)	2 MHz (minimum)
Leakage Inductance (pins 1-5 with pins 3-4 shorted, pins 10-18 shorted)	15 µH (maximum)

Table 2. Transformer Electrical Specifications.

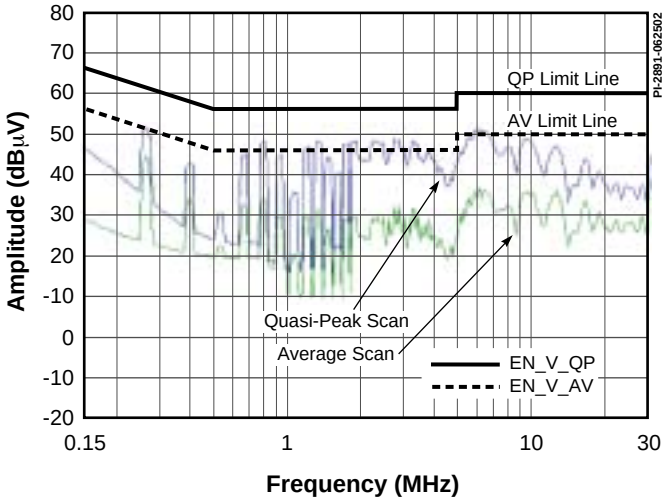

Figure 2. Conducted EMI (230 VAC, 43 W).

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