

DI-16 Design Idea

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 | TOP246YN | 43 W cont, 57 W pk | 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 M Ω , 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.
- A soft-finish capacitor (C20), eliminates start-up output overshoot.

PERFORMANCE SUMMARY

| | |
|----------------------|--------------------------|
| Output Power: | 45 W Cont./ 57 W Peak |
| Regulation: | |
| 3.3 V: | $\pm 5\%$ |
| 5 V: | $\pm 5\%$ |
| 12 V: | $\pm 7\%$ |
| 18 V: | $\pm 7\%$ |
| 33 V: | $\pm 8\%$ |
| Efficiency: | $\geq 75\%$ |
| No-Load Consumption: | 0.6 W |

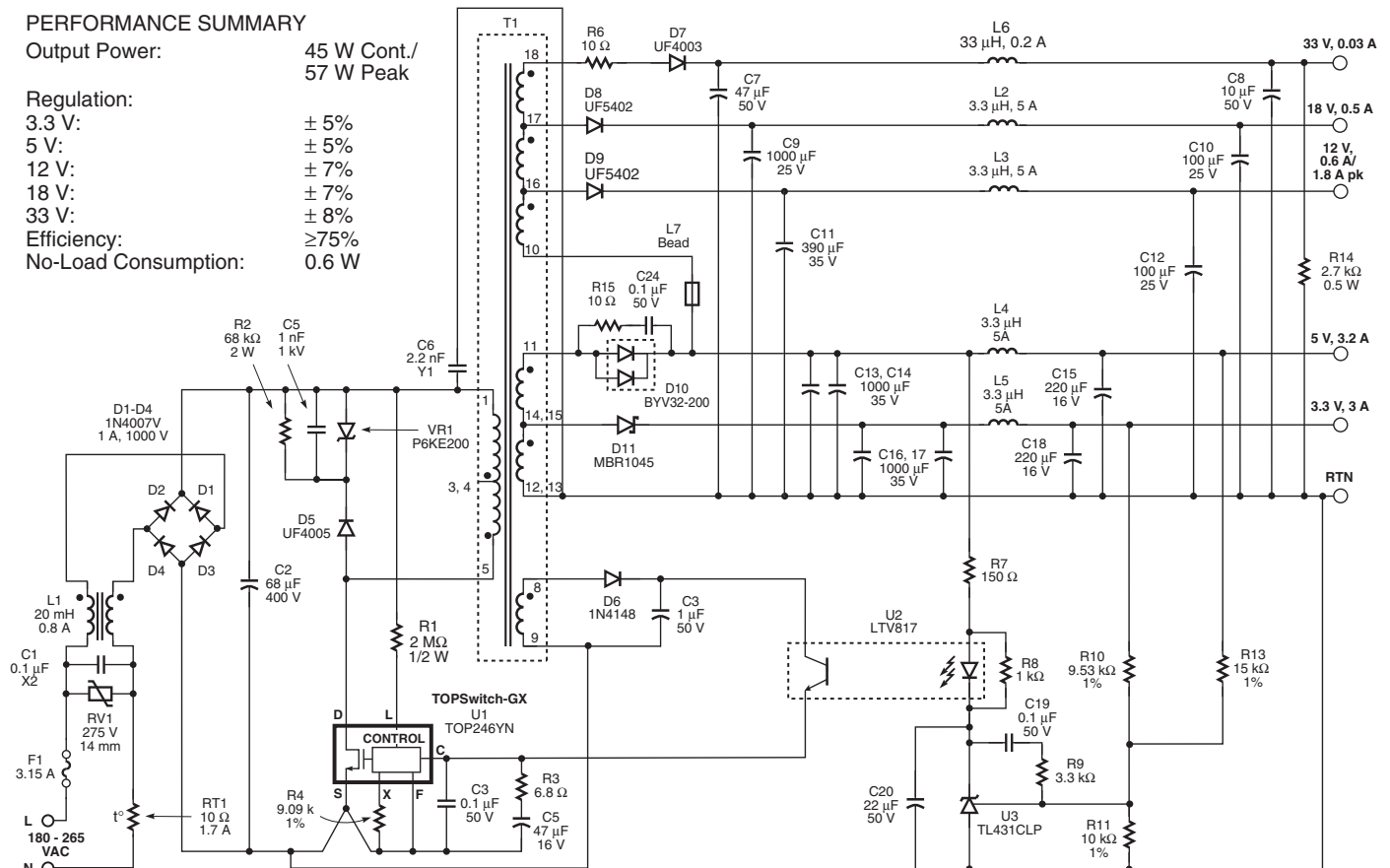


Figure 1. TOPSwitch-GX 60 W Set-top Box Multi-Output Power Supply.

- 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.

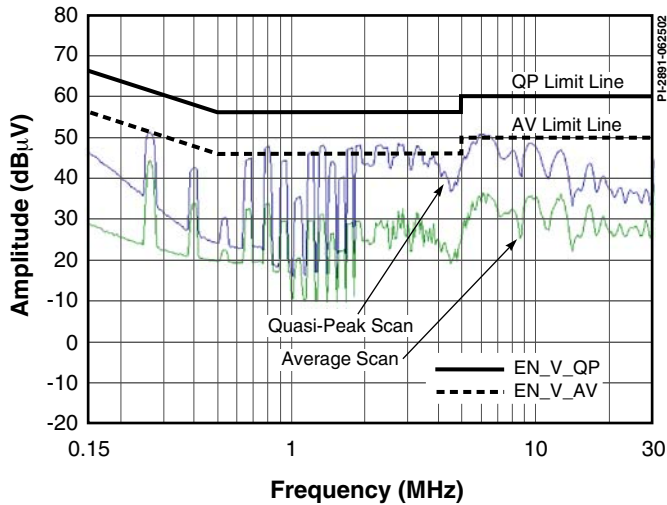


Figure 2. Conducted EMI (230 VAC, 43 W).

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, gapped 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.

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