DI-142 Design Idea
TOPSwitch™-HX

35 W LCD Monitor Power Supply

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
LCD Monitor	TOP258PN	35 W	90 – 265 VAC	5 V, 12 V	Flyback

Design Highlights

- Low component count, high efficiency
  - >83% full load efficiency (Meets CEC 2008 requirements of 82%)
  - Delivers 35 W at 50 °C ambient without requiring an external heat sink
- Low no-load and standby power consumption
  - 0.55 W standby output power for <1 W input
  - No-load power consumption <300 mW at 265 VAC
- Integrated safety and reliability features:
  - Accurate, auto-recovering, hysteretic thermal shutdown function maintains safe PCB temperatures under all conditions
  - Auto-restart protects against output short circuits and open feedback loops
  - Output overvoltage protection configurable for latching or self recovery
- Meets EN55022 and CISPR-22 Class B conducted EMI with >10 dBµV margin

Operation

The power supply shown in Figure 1 is a universal input, 35 W output, flyback power supply using the TOP258PN device. A typical application would include LCD monitors, but the design is suitable for any applicable needing a highly energy efficient dual output power supply.

The AC input is rectified (D1–D4) and filtered (C4) and connected across the primary side power components (T1 and U1). EMI filtering is provided by components, C4, L1, C7 and C11. Thermistor RT1 limits the inrush current when the AC input is applied.

Resistors R3 and R4 program the nominal undervoltage (UV) lockout and overvoltage (OV) shutdown limits to 103 V and 450 V respectively. UV lockout protects the supply from overheating at low line and eliminates power-up and power down glitches. OV shutdown protects the power supply from line surges.

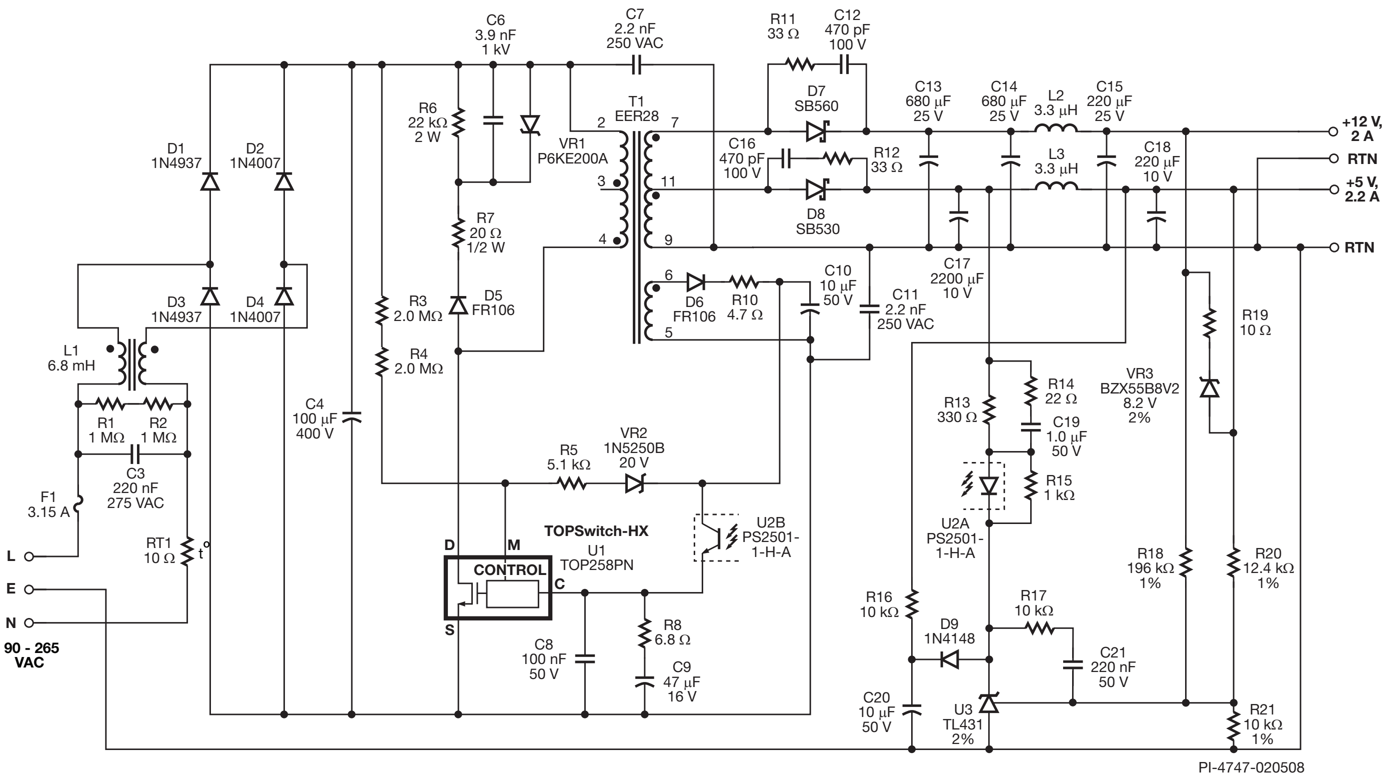

Figure 1. Universal Input, 35 W Output, LCD Power Supply, Using a TOP258PN Device.

Zener diode VR2 and resistor R5 form an optional latching output overvoltage protection (OVP) circuit. Increased voltage at the output will also result in an increased voltage at the output of the bias winding across C10. Zener VR2 will breakdown and current will flow into the Multifunction (M) pin of IC U1, thus initiating a hysteretic OV shutdown. The value of R5 determines if the shut down is latching or non-latching.

For extremely low power levels, U1 operates in the multi-cycle modulation mode for excellent efficiency that extends down to no-load and standby power levels.

Due to the 700 V BV_{DSS} rating of U1 the transformer turns ratio (V_{OR}) can be selected to allow a low cost 60 V schottky diode (D7) to be used for the 12 V output.

Output voltage feedback is derived from both outputs for better cross-regulation. Capacitor C19 and resistor R14 form a phase boost network that provides additional phase margin to ensure stable operation and improve transient response. The feedback current is fed via U2 into the CONTROL pin of U1. This determines the duty cycle thereby providing output regulation.

Key Design Points

- Diodes D1 and D3 are selected as fast diodes for better EMI performance.
- If latching OVP is desired the value of R5 should be reduced to 20 Ω.
- Design the RCD clamp (R6, R7, C6 and D5) for normal operation thereby maximizing efficiency at light load. Zener diode VR1 provides a defined maximum clamp voltage and typically only conducts during load transients or during an overload condition.
- The secondary side snubber (R11, C12, R12 and C16) reduce high frequency secondary diode ringing and improve high frequency conducted EMI.
- Post-filters (L2/C15 and L3/C18) reduce output noise and ripple to <±1% of the respective output voltage.
- In a three wire system, placing Y capacitors (C1, C2) between line/neutral and earth reduces common mode EMI.
- Soft finish capacitor C20 ensures no output overshoot at start-up. Diode D9 isolates this capacitor from the feedback loop after start-up. Resistor R16 allows a path for this capacitor to discharge into the 5 V load.
- Resistor R19 and VR3 improve cross regulation when the 5 V output is loaded while 12 V output is unloaded.

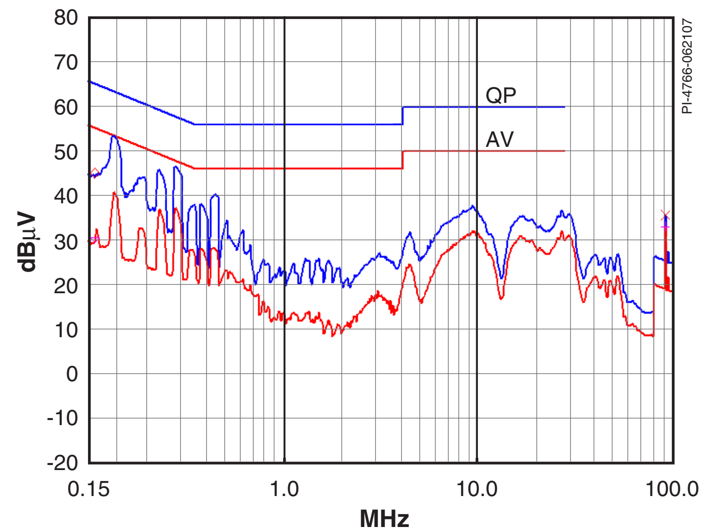

Figure 2. Worst Case Conducted EMI (230 VAC) With Output Grounded (EN55022B limits shown).

Transformer Parameters	
Core Material	EER28 NC-2H or equivalent, gapped for ALG of 213 nH/t²
Bobbin	EER28, 12 pin, horizontal
Winding Details	3mm margins on both sides of bobbin to meet safety Primary: 24T × 1 AWG 27, tape Bias: 7T × 2, AWG 26, 3 layers, tape 5 V: 3T, foil 2 mils thick 12 V: 4T × 4, AWG 26, 3 layers tape Primary: 46T × 1, AWG 27, tape
Winding Order	Primary (4-3), Bias (6-5), 5 V (11-9), 12 V (7-11), Primary (3-2)
Primary Inductance	1038 µH, ±5%
Resonant Frequency	1000 kHz (minimum)
Leakage Inductance	20 µH (maximum)

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

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