DI-143 Design Idea
TOPSwitch®-HX

High Efficiency Inkjet Power Supply Provides up to 80 Watts of Peak Power

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Inkjet Printer	TOP258MN	20 W cont, 80 W pk	90 – 264 VAC	32 V	Flyback

Design Highlights

- Low component count, high efficiency
  - Meets CEC/ENERGY STAR 2008 requirements
  - Delivers 20 W continuous and 80 W of peak power
- Very high efficiency in standby and sleep modes
  - Enables more than 0.6 W output power for 1 W input power at 240 VAC input
  - Enables more than 2.3 W output power for <3 W input power at 240 VAC input
- Very low no-load input power <300 mW at 240 VAC
- Time-triggered overvoltage protection (OVP)
- Latching fault protection and fast AC reset
- Meets EN55022 and CISPR-22 Class B conducted EMI with >10 dBµV margin
- Limited Power Source (LPS) with maximum apparent power not exceeding 100 VA in fault conditions

Operation

The isolated flyback converter shown in Figure 1 is designed around the TOPSwitch-HX IC family, the part used is TOP258MN (U4). The power supply operates from a universal input voltage range and is designed to provide a 32 V output delivering 20 W continuous with 80 W peak. The M package (10-pin DIP) allows simultaneous use of current limit programming, line sense and OVP functions. Ideal applications include inkjet printers, which typically have peak load requirements applied for very short periods.

The TOP258MN regulates the output by adjusting the duty cycle of the internal MOSFET in proportion to the current fed into the CONTROL pin. The feedback signal is provided from the secondary via a simple low cost Zener diode (VR3) and optocoupler (U2)

The EcoSmart® multimode control feature of TOPSwitch-HX provides a virtually constant efficiency over the entire load range.

To provide a constant output power with line voltage, R11, R14 and R12 linearly reduce the internal current limit of U4 as the line voltage increases. This allows the supply to limit the output power to <100 VA at high line while still delivering the rated output power at low line.

The power supply has time-triggered overload protection sensed from the primary side bias winding. During overload, the voltage across C13 rises. Once this exceeds 20 V (VR5), the latching shutdown feature of the VOLTAGE MONITOR (V) pin is triggered. The values of C9, R20 and R22 determine the delay before triggering the OV latch. Once in latching shutdown, the V pin

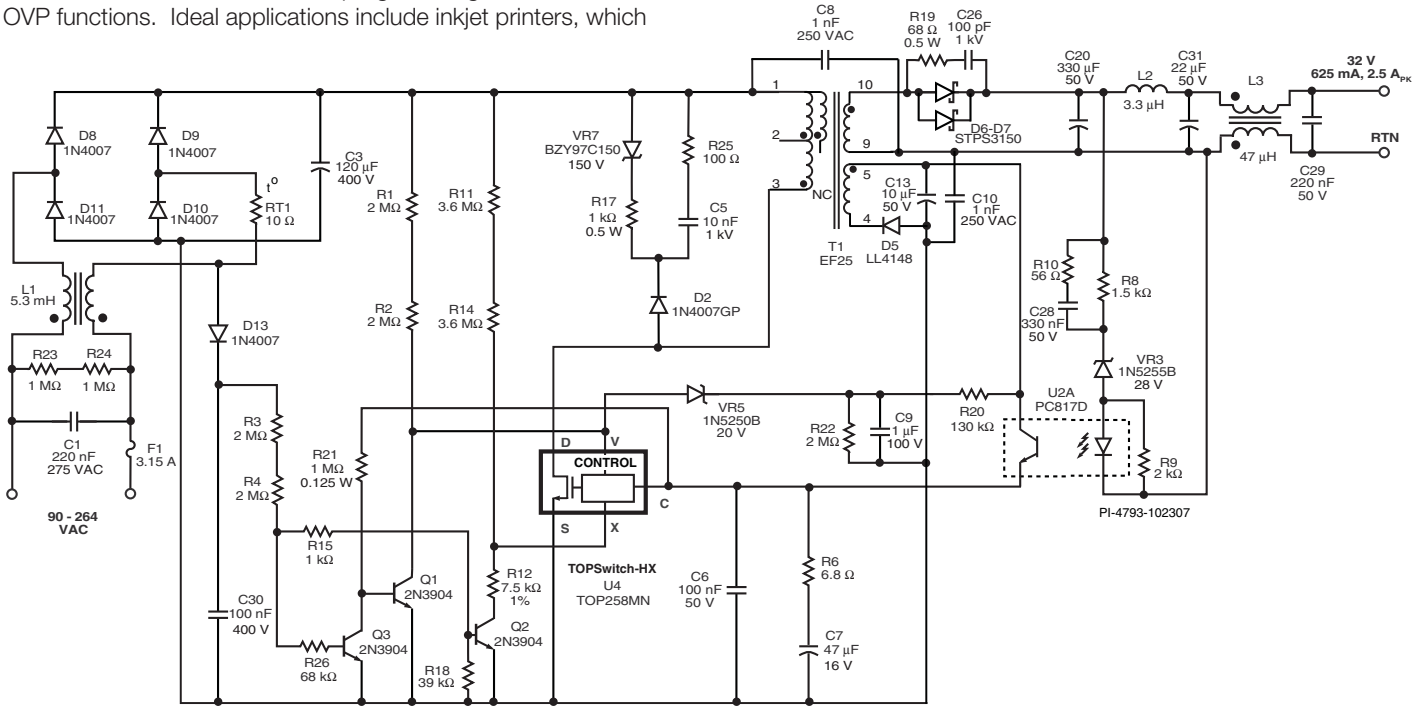

Figure 1. Universal input, 20 W Continuous, 80 W Peak Power Inkjet Printer Power Supply Using TOP258MN.

needs to discharge below a fixed threshold before switching can be reinitiated. This is accomplished by a fast AC reset circuit. On loss of AC, Q3 turns off, turning on Q1 and pulling the V pin low to reset the OVP latch.

Key Design Points

- For printers the voltage regulation requirement (±7%) allows a simple low cost Zener VR3 to be used to set the output voltage. For tighter voltage tolerances, a shunt regulator like a TL431 may be used.
- The primary clamp circuit (D2, VR7, R17, C5 and R25) provides very high light-load efficiency. Zener VR7 and R17 discharge capacitor C5 every cycle and limit to an average clamping voltage. During lower switching frequency operation, the capacitor cannot discharge below the rated voltage of VR7, which improves light load efficiency.
- Selecting D2 as a slow diode (≤2 µs recovery) allows for some of the leakage energy to be recycled into the load. If glass passivated 1N4007 is not available, the plastic FR106 may be substituted.
- Within the normal operating range, Q3 turns on, thereby turning off Q1. Resistors R1 and R2 can thus inject current into the V pin of U4 and provide line undervoltage detection. Once the current into the V pin exceeds 25 µA, switching is enabled.
- At very low input voltages, transistor Q2 turns off, thus leaving the X pin floating. This in turn inhibits switching of U4, and the power supply turns off.
- Capacitors C1, C3, C8, C10 and common-mode chokes L1 and L3 provide common mode filtering.
- Phase boost network R10 and C28 provides high frequency gain and increased phase margin.

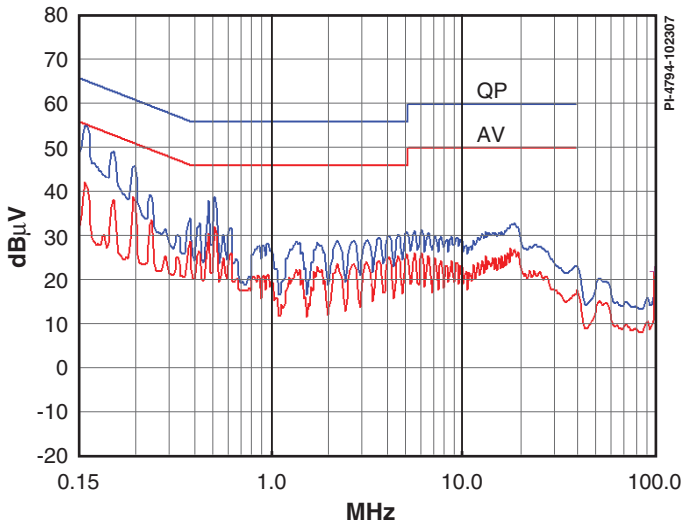

Figure 2. Worst Case Conducted EMI (230 VAC with Output Grounded).

Transformer Parameters	
Core Material	EF25 NC-2H or equivalent, gapped for ALG of 70 nH/t²
Bobbin	BEF25, 10 pin, Horizontal
Winding Details	3mm margins on primary side of bobbin to meet safety Primary: 48T x 2, AWG31, tape Bias: 9T x 4, AWG29, 3 layers, tape 32 V: 24T x 2, AWG28, TIW, 3 layers tape Shield: 10T x 4, AWG30, tape Primary: 48T x 2, AWG31, tape
Winding Order	Primary(3 – 2), Bias(5 – 4), 32 V(10 – 9) Shield(NC – 1), Primary(2 – 1)
Primary Inductance	648 µH, ±20%
Primary Resonant Frequency	1000 kHz (minimum)
Leakage Inductance	16 µH (maximum)

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

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