

DI-182 Design Idea

TOPSwitch-HX

Standard 65 W Notebook Adapter Which Meets Requirements for Energy Star 2.0 (ES 2.0)

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Notebook	TOP259EN	65 W	90 – 265 VAC	19 V ±5%	Flyback

Design Highlights

- Very compact, low part-count
- Low profile eSIP-7C Single-In-line package
 - Same thermal impedance characteristics as standard TO-220 package
 - Allows lower overall height and smaller board footprint
 - Clip mounted eSIP package easily passes shock and vibration test to IEC60068
- Highly energy efficient
 - Very low no-load input power: <250 mW at 230 VAC
 - High average efficiency: >87.5% meeting ENERGY STAR v2.0 draft requirements (measured at the end of cable: 1.8 m, 18 AWG, 100 mΩ impedance)
- 132 kHz operation allows small transformer (EE28)
- Internal current-limit reduction vs line-voltage increase removes need for secondary side current limiting used to meet power-limited source requirements
- Accurate hysteretic thermal shutdown protection
- Timed over-load protection with automatic recovery
- Meets CISPR-22/EN55022 B conducted EMI limits

Operation

The power supply design shown in Figure 1 utilizes the TOP259EN. The TOPSwitch-HX products integrate a 700 V MOSFET with a multi-function PWM controller in one device. The optimized combination of switching MOSFET and integrated driver present for low switching loss enable a highly efficient and compact 65 W notebook power supply able to safely operate in a sealed enclosure up to an ambient temperature of 40 °C.

The bridge rectifier BR1, at the input of the power supply, rectifies the line input; electrolytic capacitor C2 filters the input. Fuse F1 protects against catastrophic failure. Common mode EMI is filtered by L1, L2, L3, C3, and C11. Common-mode choke L2 filters lower frequencies while L3 filters higher frequencies.

Differential filtering is provided by the leakage inductance of L2 and X capacitor C1. As C1 has a capacitance greater than 0.1 μF, discharge resistors R1 and R2 are required to discharge C1 after removal of AC. To reduce differential EMI generation C5 provides decoupling for the primary switching current.

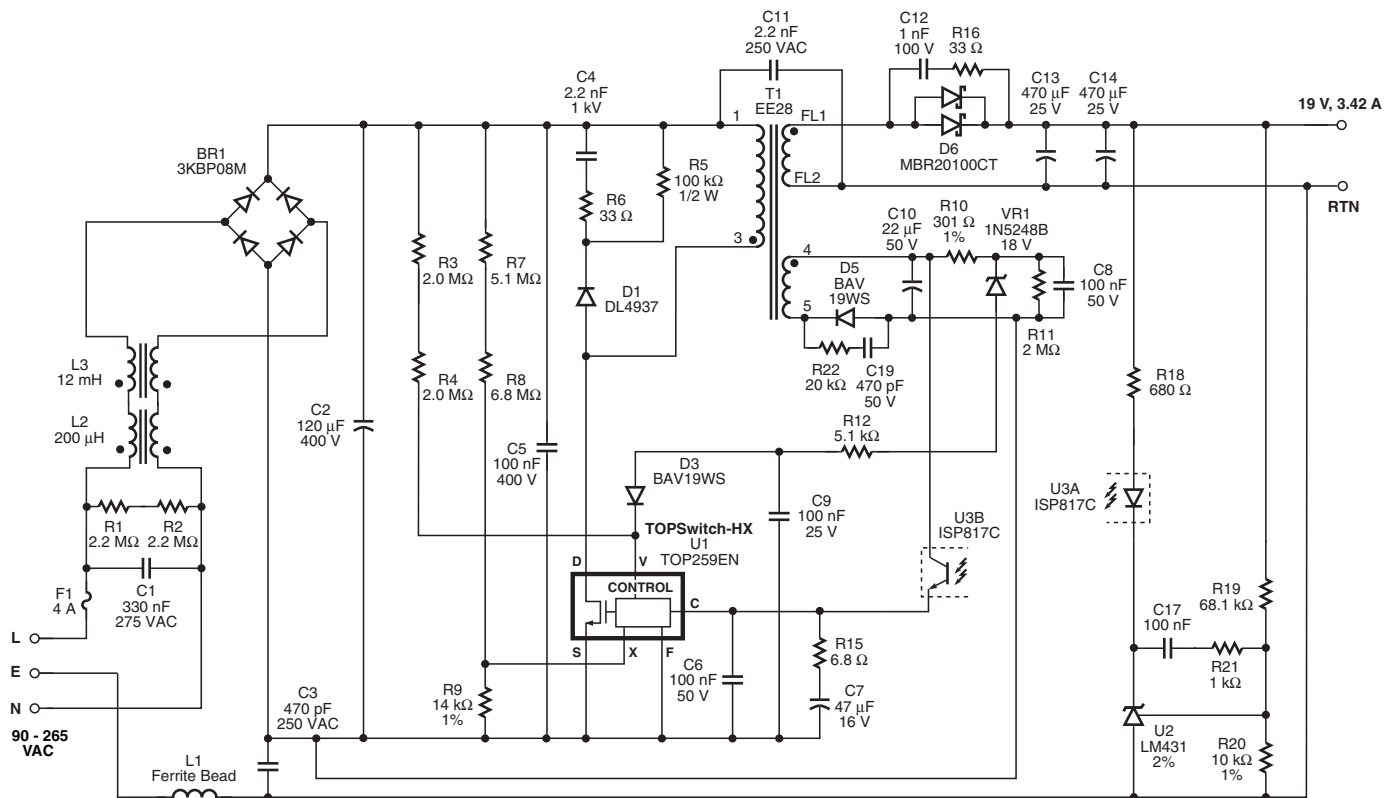


Figure 1: Schematic of a 65 W Notebook Adapter Power Supply Using TOPSwitch-HX TOP259EN.

The TOP259EN, with its integrated multi-mode controller, is used in a flyback configuration. It maintains output regulation by changing the duty cycle as a function of the control pin current. To maintain high efficiency across the whole load range, the multi-mode controller changes between pulse width modulation and fixed on-time variable frequency control. To provide constant output overload power with changing line voltage, as line voltage increases, resistors R7, R8, and R9 reduce the internal current limit of the TOP259EN. This allows the supply to limit the output overload power to <100 VA at high line, while still delivering the rated output at low line.

The primary side's output overvoltage protection (OVP) senses the bias-winding voltage using Zener diode VR1. This is used to provide both open-loop protection and output-overload protection under a single-fault condition. Resistors R10 and R11 with capacitor C8 determine the delay before shutdown is triggered. This prevents false triggering during startup and load transients. The value of R12 selects the hysteretic shutdown behavior of U1. Capacitor C9 helps to filter high frequency noise that may appear on the V pin.

The output is rectified by diode D6 which has an RC snubber (C12 and R16) to dampen leakage inductance ringing and reduce radiated EMI. The output is filtered by capacitors C13 and C14.

Feedback is derived from the output via optocoupler U3A. Resistor R18 sets the DC gain. Shunt regulator U2 has an accurate internal voltage reference, and with resistors R19 and R20, sets the output voltage to 19 V.

Diode D3 prevents loading of the V pin by the OVP circuit and also isolates the line sense circuit from the OVP circuit.

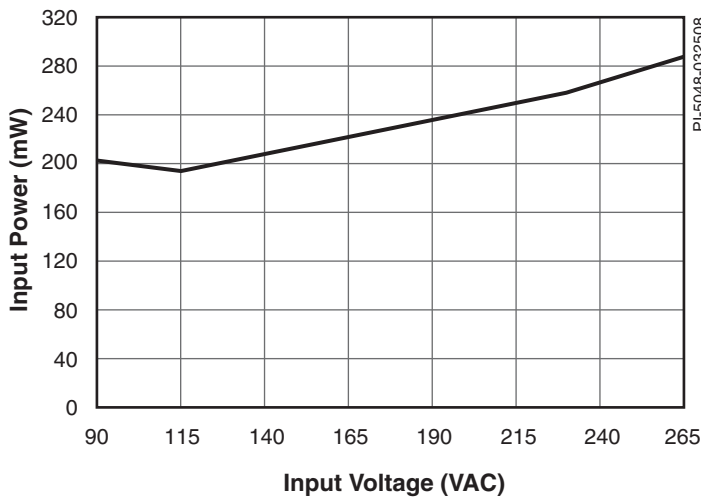


Figure 2. No Load Input Power vs. Line Voltage.

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Key Design Points

- Verify that the maximum drain voltage does not exceed 650 V at high line and maximum overload. Adjust the values of C4 and R5 as necessary.
- Resistor R6 dampens high frequency ringing and improves EMI.
- Select the value of VR1 such that it does not falsely trigger OVP. VR1 should be chosen above the bias-winding voltage measured under low line and full load conditions.
- If latching OVP is desired, select R12 as 20 Ω .
- U1 does not require an insulating pad for reduced EMI. It has a tab connected to the electrically “quiet” source.

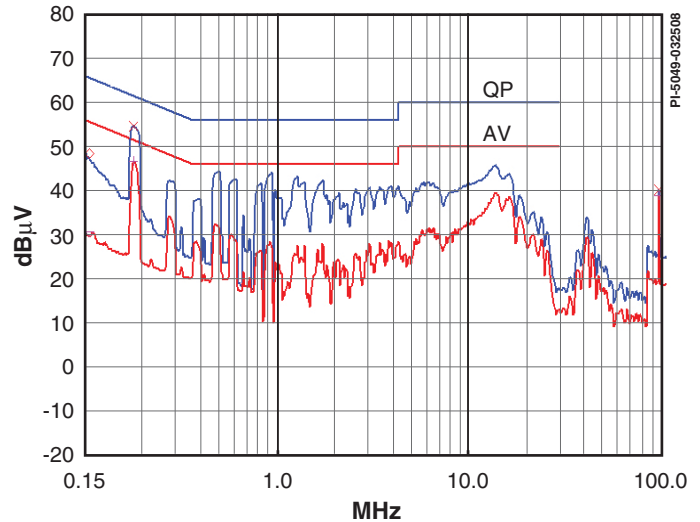


Figure 3. Conducted EMI, EN55022 B Limits. Measurements Made at 230 VAC With 5.6 Ω Resistive Load (Output Grounded).

Transformer Parameters

Core Material	EE28, TDK or equivalent, gapped for ALG of 299 nH/t ²
Bobbin	Vertical 10 pin, pin 6 to pin 10 are to be removed
Winding Details	Bias: 5T \times 3, 30 AWG Primary 1: 17T \times 2, 26 AWG Shield: 1T Cu foil, 1 mil thick Secondary: 6T \times 4, 26 AWG-TIW Shield: 1T Cu foil, 1 mil thick Primary 2: 17T \times 2, 25 AWG
Winding Order	Bias (4-5), Primary-1 (3-2), Shield (1-NC), Secondary (FL1-FL2), Shield (1-NC), Primary-2 (2-1)
Primary Inductance	343 μ H, \pm 5% at 132 kHz
Primary Resonant Frequency	1.1 MHz (minimum)
Leakage Inductance	4 μ H (maximum)

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

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