DI-148 Design Idea
PeakSwitch®

Multiple Output Flyback Power Supply for Audio Amplifier Using Magnetic Amplifiers to Achieve Better Cross Regulation

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
Audio	PKS607YN	75 W, 126 W Peak	195 - 265 VAC	±26 V, ±15 V, 5 V	Flyback

Design Highlights

- Effectively replaces linear transformer-based power supplies in home audio applications
- Dramatically reduces weight, allowing chassis cost reduction
- Proprietary magnetic amplifier (mag amp) approach enables tight cross regulation of two main outputs in flyback topology
- Low component count, compact and light weight.
- Energy efficiency
  - >82% efficiency at full load
  - <800 mW no-load power consumption at 265 VAC
  - Reduces heat sink requirements and eliminates need for separate standby supply
- Excellent transient response – improves audio quality
- Integrated frequency jittering, together with a simple EMI filter, allows for CISPR-22/EN55022B conducted EMI compliance (see Figure 2)
- Integrated safety/reliability features:
  - Accurate, auto-recovering, hysteretic thermal shutdown function maintains safe PCB temperatures under all conditions
  - Latching shutdown protects against output short circuits and open feedback loops

Operation

The universal input power supply shown in Figure 1 has multiple outputs, ±26 VDC, ±15 VDC, and +5 VDC. The ±26 V outputs can each deliver a minimum output current of 2.42 A peak (thermally limited) and 1.45 A continuous. Additionally, the voltage regulation and, importantly, transient response is excellent over the entire load range (no-load to full load).

The controller in U1 skips switching cycles to regulate the output voltage, based on feedback to its EN/UV pin. When the current pulled out of this pin exceeds 240 µA, a low logic level (disable) is generated. At the beginning of each cycle, the EN/UV pin state is sampled, and if high, the power MOSFET is turned on for that cycle (enabled); otherwise the power MOSFET remains off (disabled). During start-up, switching is inhibited until the input voltage is above the under-voltage threshold, determined when a current >25 µA flows into the EN/UV pin.

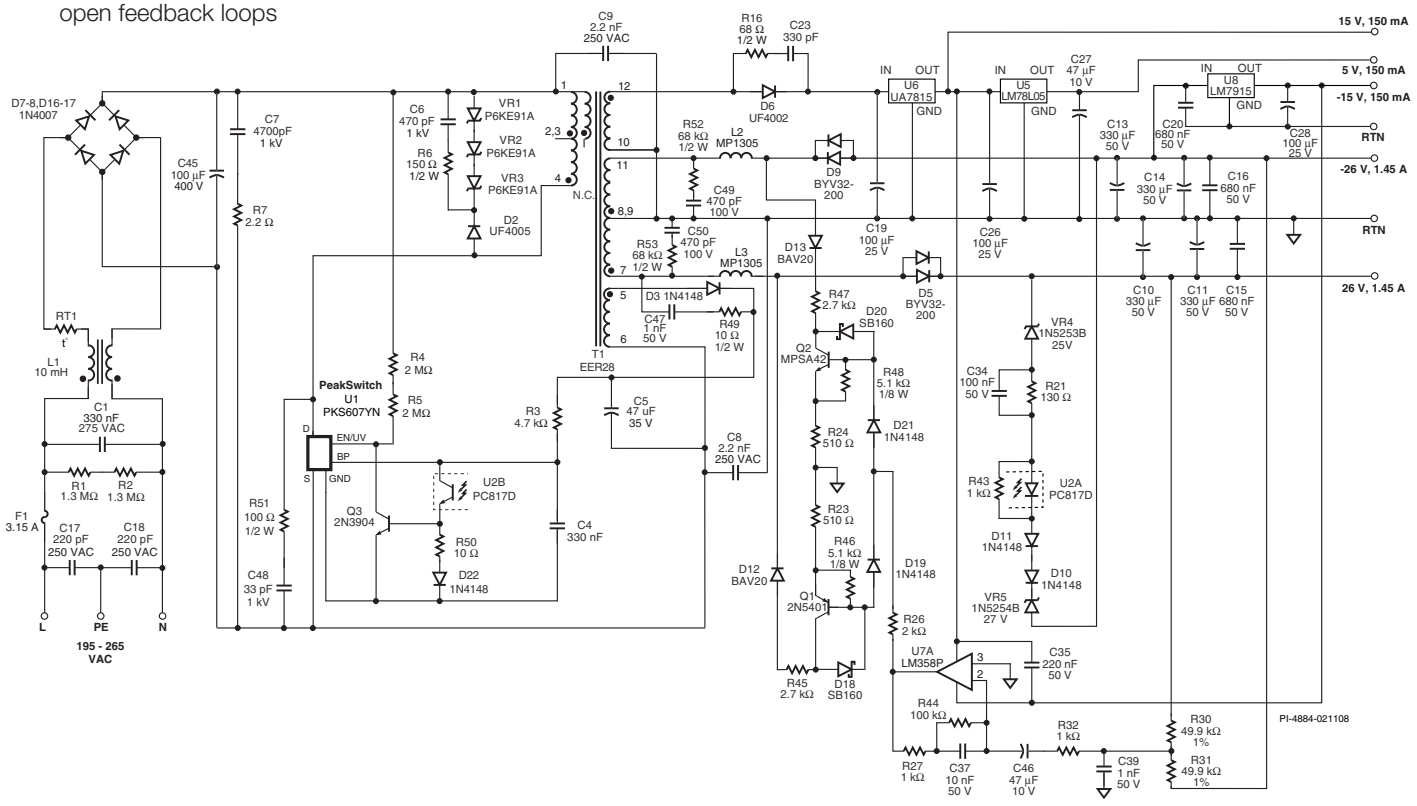

Figure 1. Schematic of a 75 W Continuous and 126 W Peak Audio Amplifier Power Supply.

The primary feedback circuit is closed across the ±26 V (52 V) outputs via VR4, U2A and VR5. This ensures that the sum of voltages across the ±26 V outputs is regulated. For improved cross-regulation, two separate magnetic amplifiers (mag amps) are used on the ±26 V outputs. A mag amp is a saturable reactor or inductor that uses a core material that has a rectangular B-H curve. Adjusting the current (magnetic flux) in the mag amp adjusts the period that it blocks current flow.

Here two magnetic amplifiers (L2 and L3) are used for improved cross regulation. This is especially relevant for audio designs as power is drawn from the supply at audio frequencies. The highest output power component occurs at lower frequency where current is alternately drawn from each output but not simultaneously.

By adjusting the current in L2 and L3, the circuitry formed by U7A, Q1 and Q2 determines the proportion of the energy stored in the transformer that is delivered to the +26 V and -26 V outputs during the off time of the PeakSwitch internal MOSFET. At the extreme, with one output fully loaded and the other at no-load, almost all the energy is delivered to the output under full load. Importantly, both outputs cannot be simultaneously blocked, which would cause excessive clamp dissipation. Even with very large load transients 25%-100% that are common in audio supplies, the output regulation is maintained within ±5% on both outputs.

Common mode choke, L1, and the two Y-capacitors, C8 and C9, form the common mode EMI filter. Common mode choke L1 also works in conjunction with X-capacitor C1 to provide differential mode EMI filtering.

Key Design Points

- The high crest factor of the music source allows physically smaller heatsinks.
- The auxiliary ±15 VDC and +5 VDC outputs are obtained from a linear regulator. To limit the power dissipation in the (5 V and 15 V) linear regulators, a second 18 V output was added to transformer T1.
- As the value of X capacitor C1 is above 0.1 µF, safety agency requirements specify that it R1 and R2 should be used to discharge C1. Resistors R1 and R2 are chosen such that (R1 + R2) × C1 ≤ 1 s.
- To reduce grouping of switched cycles, a high gain optocoupler, U2, was used to drive small signal transistor Q3, which pulls current out of the EN/UV pin. Capacitor C34 adds high frequency gain to the feedback signal.
- In a three wire system, placing Y capacitors (C17, C18) between line/neutral and earth helps reduce common mode EMI.
- The core size and the winding wire diameter sizes (see Table 1) were chosen based on the average of the peak and the continuous output power.
- An RC snubber (R51and C48) was added between drain and source of U1 to reduce radiated EMI.

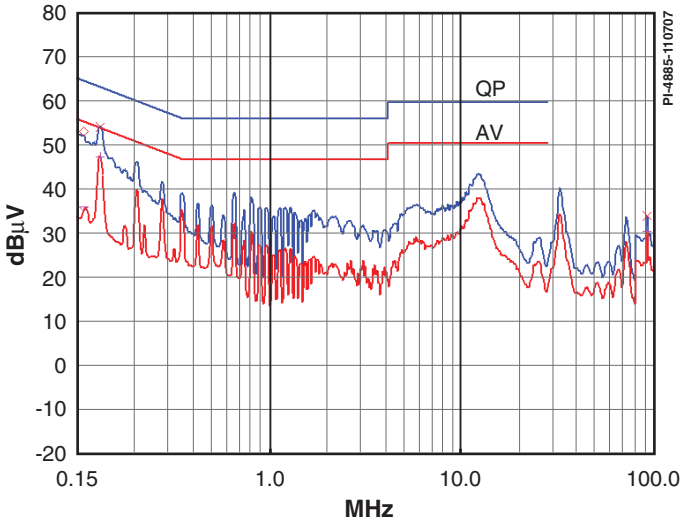

Figure 2. Conducted EMI at 230 VAC With Output Grounded (Worst Case).

Transformer Parameters

Core Material	EER28 NC-2H or equivalent, gapped for ALG of 139 nH/t²
Bobbin	EER28, 12 pin, Vertical
Winding Details	Add 3 mm margins on both sides of bobbin Primary: 16T × 2, AWG30, tape Shield: 1T × 1, foil 2 mils thick, 3 layers tape +26 V: 8T × 2, AWG23, 1 layer tape -26 V: 8T × 2, AWG23, 1 layer tape 18 V: 6T × 2, AWG28, tape Bias: 5T × 2, AWG30, tape Primary: 17 T × 2, AWG30, 2 layers tape
Winding Order	Primary (4–2), Shield (NC–1), +26 V (7–8), -26 V (9-11), 18 V (12-10), Bias (5-6), Primary (2-1)
Primary Inductance	151 µH, ±20%
Primary Resonant Frequency	2 MHz (minimum)
Leakage Inductance	5 µH (maximum)

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

Power Integrations
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1 408-414-9200
Customer Service
Phone: +1-408-414-9665
Fax: +1-408-414-9765
Email: usasales@powerint.com

On the Web
www.powerint.com