AND8034/D

MC44608 SMPS Featuring Very Low Standby Power Consumption and Wide Range Output Voltage

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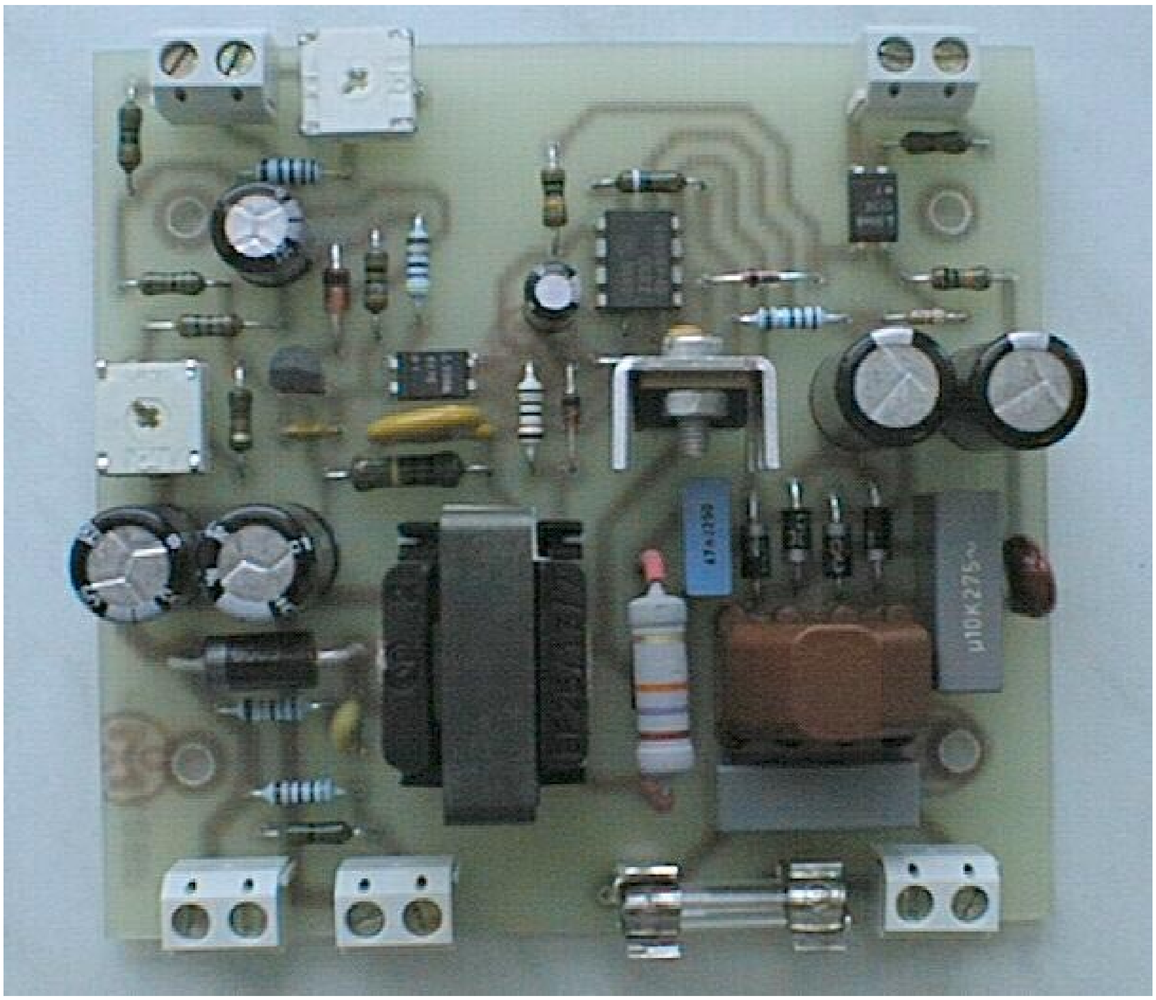
APPLICATION NOTE



As it is well known, according to power saving regulations, we need to obtain a very low power consumption during standby condition for all equipment continuously powered on the mains. For "not saving" version of power supply, the standby power consumption is around 9.0 W (for 100 W power output). When using the MC44608 GreenLine™ Power supply controller, we obtain 1.3 W in standby mode. The result is absolutely phenomenal, but still, for some special applications, the power reduction is not enough. In this case the only possibility to obtain a lower consumption in standby is to use a separate low output power supply (< 1.0 W) for powering only the microprocessor and switch off the rest of the application. The MC44608 is basically not designed for that use. However this is achievable by adding a few more components to the typical application schematic. In this case we can reach a standby power consumption as low as 200 mW.

This result largely over passes the today standby power saving recommendations, meeting the 2005 recommendation limits.

Final price cost of additional components is below then 0.5 US$ and the total price of this power supply remains the same, compared to typical application circuitry, since all components dealing with the reconfiguration of secondary side can be removed.

The basic idea to reach this performance is to power the IC in the phase, in which it has the lowest power consumption. At the same time is necessary to stop the operation of the output stage and leave IC in steady state conditions. In this case the secondary side output reconfiguration topology is not used.

Schematic of whole SMPS is presented in Figure 1.

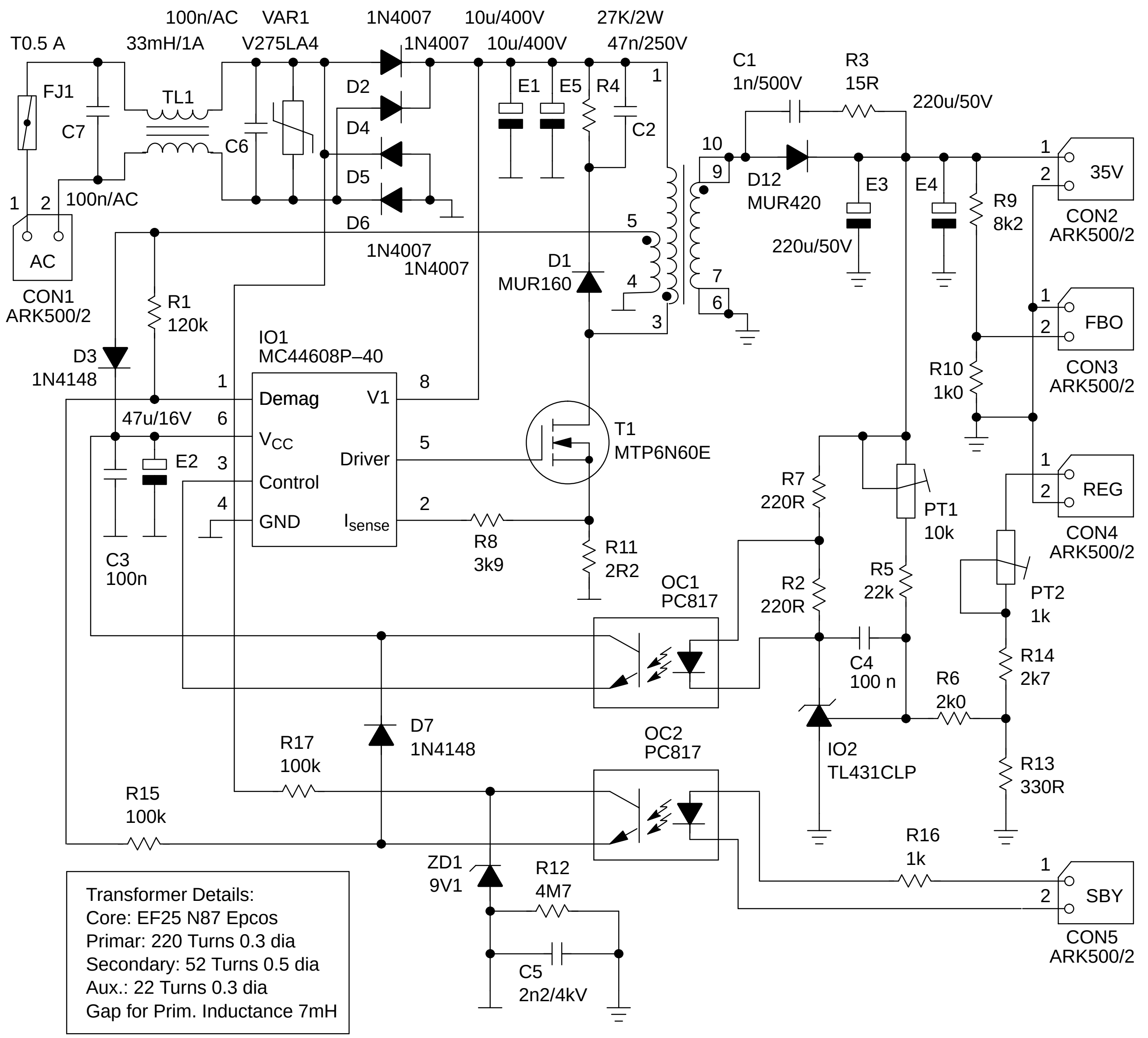


Figure 1. Schematic of SMPS

As shown in Figure 1, the schematic includes all components to build a real application: safety fuse, input EMI filter, over voltage protection and rectifier, two filtering capacitors (2 capacitors for smaller ESR and therefore lower the EMI radiation). The power switch used here is the MTP6N60E. A standard RDC clamp in parallel with the primary winding is used as a spike protection. At the source of power switch a current sensing resistor R11 leads the signal to I_{sense} pin of the IC through R8. The aux. winding of the transformer is used to power the V_{cc} pin of the IC and also provides demagnetization information. On the secondary winding the diode D12 supplies energy for secondary load. This diode is protected against voltage spikes by RC series combination (C1, R3). This voltage is used to feed control loop through the opto coupler OC1. This regulation is based on standard shunt regulator using monolithic TL431CLP.

To put the SMPS in standby mode a simple circuit (OC2, R16, R15, D7, ZD1) is added. When a 5.0 V logic signal is present on the standby connector, through the opto coupler OC2 a signal feeds the demag input of control IC. This causes a permanent stop of output signal and no more energy is transferred. The Vcc pin of the IC is now supplied through R17 and D7. The Vcc is maintained at a voltage higher 6.5 V and below 10 V. The IC remains in a latched off phase. The total consumption in this case is well below 200 mW.

We add an additional feature to drive the output voltage from a microcomputer.

Potentiometer PT2, R13, R14, R6 feed the control loops. R9 and R10 send the correction information to the microcomputer. Output voltage range and gain of control signal are adjustable by potentiometers PT1 and PT2.

In the table below are summarized measured values:

Input Voltage	Input Power	Output Power	Efficiency
200 V	20.0 W	16.3 W	81.5%
230 V	20.0 W	16.3 W	81.5%
260 V	20.0 W	16.3 W	81.5%
For maximal output power			
230 V	22.8 W	19.6 W	85.9%

The plots below show some waveforms at critical test points:

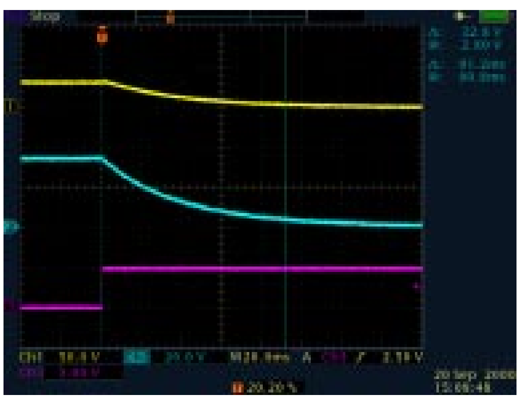


Figure 2. Output Voltage After Switch Off

Trace 1: Voltage at cathode of TL431CLP
Trace 2: Output voltage
Trace 3: Control signal for standby

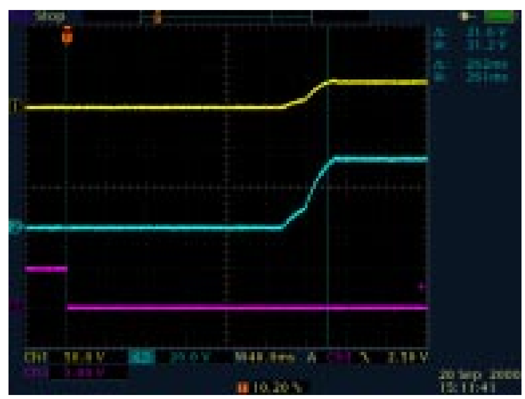


Figure 3. Output Voltage After Switch On

Trace 1: Voltage at cathode of TL431CLP
Trace 2: Output voltage
Trace 3: Control signal for standby

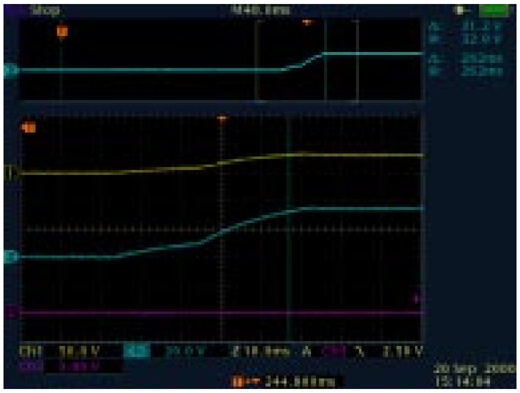


Figure 4. Zoomed Rising Edge of Figure 3

Trace 1: Voltage at cathode of TL431CLP
Trace 2: Output voltage
Trace 3: Control signal for standby

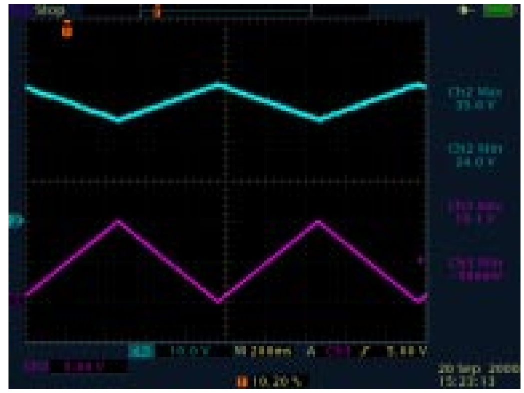


Figure 5. Output Voltage Regulation

Trace 2: Output voltage
Trace 3: Control signal for voltage regulation

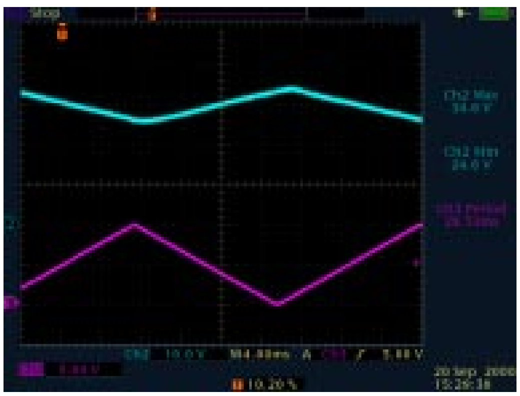


Figure 6. Minimal Period of Regulation

Trace 2: Output voltage
Trace 3: Control signal for voltage regulation

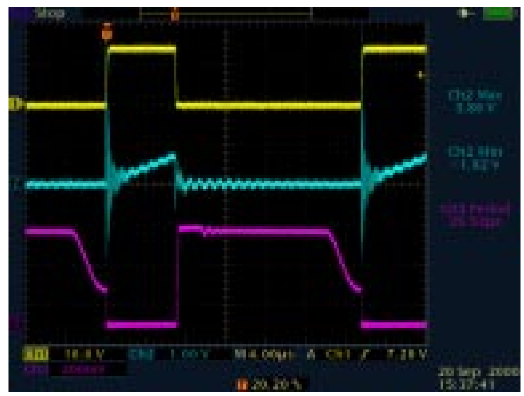


Figure 7. Primary Side Waveforms

Trace 1: Voltage at gate of power switch
Trace 2: Drain current of power switch
Trace 3: Drain voltage of power switch

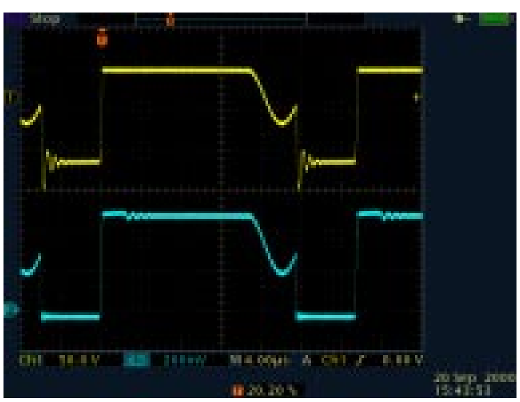


Figure 8. Switching Waveforms

Trace 1: Voltage at pin 10 of transformer
Trace 2: Voltage at pin 3 of transformer

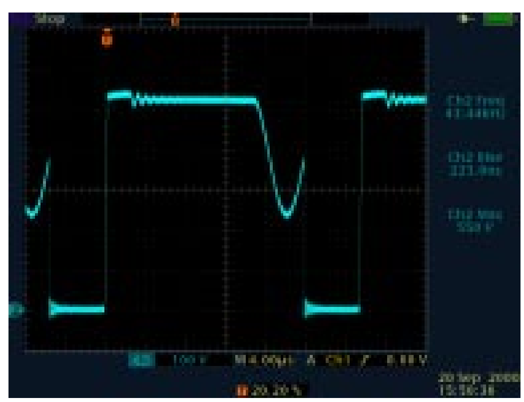


Figure 9. Primary Side Waveform

Trace 2: Detailed drain voltage of power switch

Notes

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