High Voltage Power Supply Using the TPS61040

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ABSTRACT

The TPS61040 is a highly integrated, low power, boost converter capable of delivering output voltages up to 28 V. The addition of two small diodes and two small capacitors enables the TPS61040 to deliver output voltages up to 50 V.

The maximum allowable voltage on the SW pin of the TPS61040 limits the output voltage to 28 V. The addition of C2, C5, D2, and D3 allow the supply to deliver output voltages over 50 V. The circuit shown in Figure 1 generates a 50 V output at up to 15 mA, depending upon input voltage. The portion of the circuit within the dotted line is a basic boost topology based upon the TPS61040. Steady state operation of the supply is described below.

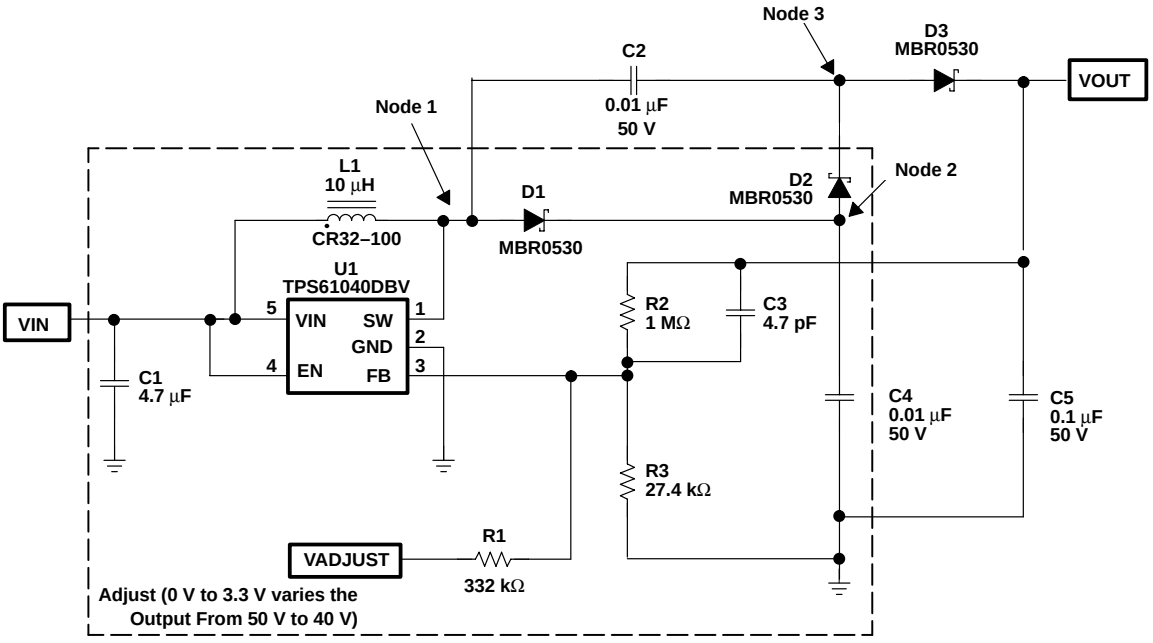

Figure 1. Example Power Supply Using the TPS61040

When the internal power switch of the TPS61040 is closed, current flows from the input, through L1, through the internal switch, to ground. During this time, the voltage at node 1 is 0 V and the voltage at node 2 is equal to 25 V (Vout/2). D2 is forward biased, so the voltage at node 3 is also 25 V. This charges C2 up to 25 V. D3 is reverse biased during this time, so the output current is supplied by the output capacitor, C5.

When the power switch opens, current flows through L1 and D1 into C4. D1 is now forward biased; therefore, the voltage at node 1 is equal to the voltage on C4 (25 V). C2, which was previously charged to 25 V is now referenced to node 1. The voltage across C2 remains at 25 V, but the left side is 25 V with respect to ground and the right side is 50 V with respect to ground. As node 3 is forced to 50 V, D3 becomes forward biased and C5 is charged to 50 V. D2 is reverse biased during this time period.

The output is regulated to 50 V through the feedback divider that goes back to the FB pin of the TPS61040. An unregulated output voltage of 1/2 Vout is available from node 2 in this configuration. If desired, the feedback can be recalculated for a 25 V output and connected to node 2. This provides a regulated 25–V output and an unregulated 50–V output.

D1, D2, and D3 must be rated for at least 1/2 the output voltage. The peak current ratings for the diodes must be greater than 1/2 the peak switch current of the TPS61040 (400 mA for the TPS61040 and 250 mA for the TPS61041). C2 and C3 must have voltage ratings greater than 1/2 the output voltage, while C5 must be rated for the full output voltage. The required capacitance of C2 and C3 can be roughly calculated by the equation shown below. A higher value capacitance may be chosen with no adverse effects on the power supply; however, reducing the capacitance may cause excessive ringing and jitter in the output voltage waveform.

$$C2,4 \equiv \frac{Ipk \times Ipk \times L1}{0.1 \times Vout \times (Vout - Vin)}$$

Where: Ipk = peak switch current of the TPS61040 (400mA),

L1 = inductor value,

Vout = output voltage, and Vin = input voltage.

Injecting a *voltage control* signal through R1 into the FB pin varies the output voltage of the supply. With the values shown in Figure 1, a 0 V control signal generates a 50 V output voltage and a 3.3 V signal generates a 40 V output voltage. More information about varying the output voltage of a TPS61040 controlled boost converter may be found in TI literaure number SLVU065.

References

1. *TPS61040 data sheet* (Texas Instruments literature number SLVS413)
2. *TPS61040EVM–001 Users Guide* (Texas Instruments literature number SLVU065)

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