Application Brief

High-Side MOSFET Driver Power Supply Using the TPS61041-Q1

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Boost and Multi-Channel Phase DC/DC

Introduction

Designing a MOSFET driver supply for a 12-V car supply is quite challenging. The 12-V battery supply voltage is normally in the range of 9 V to 16 V under normal operating conditions depending on charge and load variation. The TPS61041-Q1 is a high-frequency, low-cost boost converter dedicated for a small to medium supply. The device allows the use of small external components, which gives a very small overall solution size. However, its input voltage range is from 1.8 V and 6 V. This application brief proposes an external circuit that can generate an output voltage following the input voltage adjustment and change.

For automotive applications that require a high-side MOSFET driver, the MOSFET gate needs a stable stepped-up voltage to ensure the MOSFET is fully turned on. The 12-V battery supply voltage is normally in the range of 9 V to 16 V under normal operating conditions depending on charge and load variation. Therefore, the driver voltage should follow the input voltage adjustment and change. Figure 1 shows the block diagram.

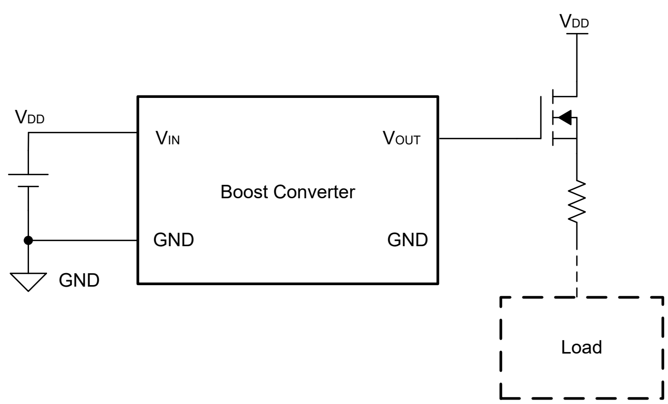

Figure 1. Block Diagram

Table 1. High-Side MOSFET Driver Circuit Specification

V_{DD}/V	V_{OUT}/V	I_{OUT}/mA
9 V to 16 V	V_{DD} + 10 V	5 V

The TPS61041-Q1 is a high-frequency boost converter dedicated for low-power applications. The device is ideal to generate output voltages up to 28 V from 1.8-V to 6-V input voltage range. The TPS61041-Q1 operates with a switching frequency up to 1 MHz.

This document introduces a circuit to generate the high-side MOSFET driver voltage using the TPS61041-Q1. Theoretical analysis and bench test results are presented to verify the proposed circuit. Table 1 shows the circuit specification.

Proposed Circuit Principle

Figure 2 shows the schematic of a boost converter using the TPS61041-Q1. Because the TPS61041-Q1 recommended input voltage maximum value is 6 V, the device VIN and GND pin cannot be connected to 12-V car battery directly. A level-shift circuit composed of D3, D2, and Q1 pulls up the IC GND pin voltage potential.

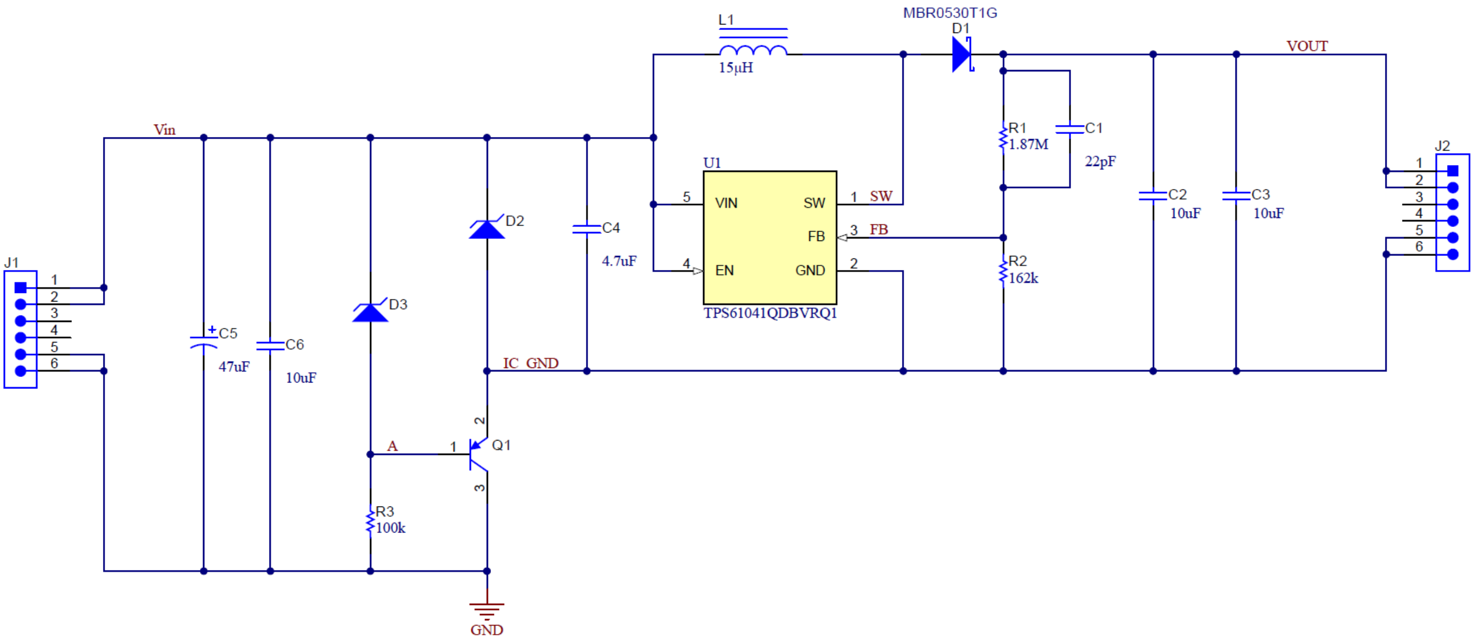

Figure 2. Proposed Schematic

D3 is a Zener diode that clamps the PNP transistor Q1 base voltage V_A to:

$$V_A = V_{in} - V_Z \tag{1}$$

The PNP transistor Q1 turns on, IC_GND voltage follows the calculation in Equation 2:

$$V_{IC\_GND} = V_A + V_{BE} \tag{2}$$

In this application, a 6-V Zener diode is selected for D3. So, the TPS61041 VIN pin to GND pin voltage is clamped to below 6 V to protect the IC. Set the TPS61041 output voltage to 10 V higher than V_{in} as in Equation 3:

$$V_{OUT} = V_{IC\_GND} + V_{ref} \times \left(1 + \frac{R_1}{R_2}\right) = V_{in} - V_Z + V_{ref} \times \left(1 + \frac{R_1}{R_2}\right) \tag{3}$$

Where Vref is 1.233 V.

Set R_1 at 1.87 MΩ and R_2 at 167 kΩ. Assume the PNP transistor VBE is 0.3 V, the $V_{OUT} – V_{in}$ equals 9.63 V.

Bench Test Result

Using the setup shown in Figure 2, the Vin line transient waveform is shown in Figure 3. When Vin is 9 V, the TPS61041-Q1 device output voltage is 19 V. When Vin is 16 V, the TPS61041-Q1 device output voltage is 26 V. The device V_{OUT} is always 10 V higher than input voltage.

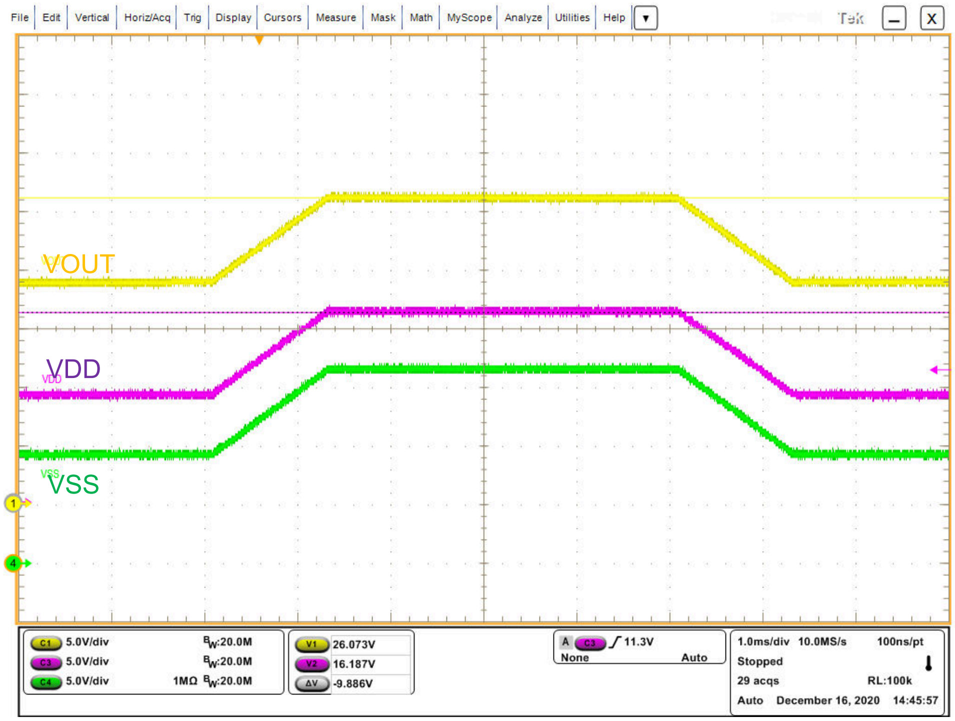

Figure 3. V_{in} 9-V to 16-V Line Transient Waveform

Summary

This document proposes an external circuit that can generate an output voltage following the input voltage adjustment and change by using the high-efficiency low-cost boost converter, TPS61041-Q1.

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