*Application Report*
*SLVA985–October 2018*

# *Negative to Positive Conversion Made Simple with TPS61089 Boost Converter*

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**ABSTRACT**

Some applications need to convert a negative input voltage to a positive output voltage. This application note is a simple, cost effective and high efficiency solution for a -5 V to +5 V conversion.

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## Trademarks

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# 1 Introduction

The TPS61089 is a fully-integrated synchronous boost converter with a 19-mΩ main power switch and a 27-mΩ rectifier switch. The device provides a high efficiency and small size power solution for portable equipment. The TPS61089 features wide input voltage range from 2.7 V to 12 V to support applications powered with single cell or two cell Lithium ion/polymer batteries. The TPS61089 has 7-A continuous switch current capability and provides output voltage up to 12.6 V.

This application note is a simple and low cost solution for a -4 V to -6 V input, 5 V output and 2 A load current application by using the TPS61089 boost converter.

# 2 Design Process

## 2.1 Schematic

Figure 1 shows the schematic for this application note. The ground of the IC is referenced to the negative input voltage. To obtain a positive output, a level shifter is implemented. It uses a current mirror built with two inexpensive PNP transistors to regulate the output voltage. For best performance and tighter regulation accuracy, a matched pair can be used so that the two VBE are cancelled out. The current flowing through R12 is $V_{REF}$/R12, so the TPS61089 output voltage is $V_{REF}$ × R10/R12.

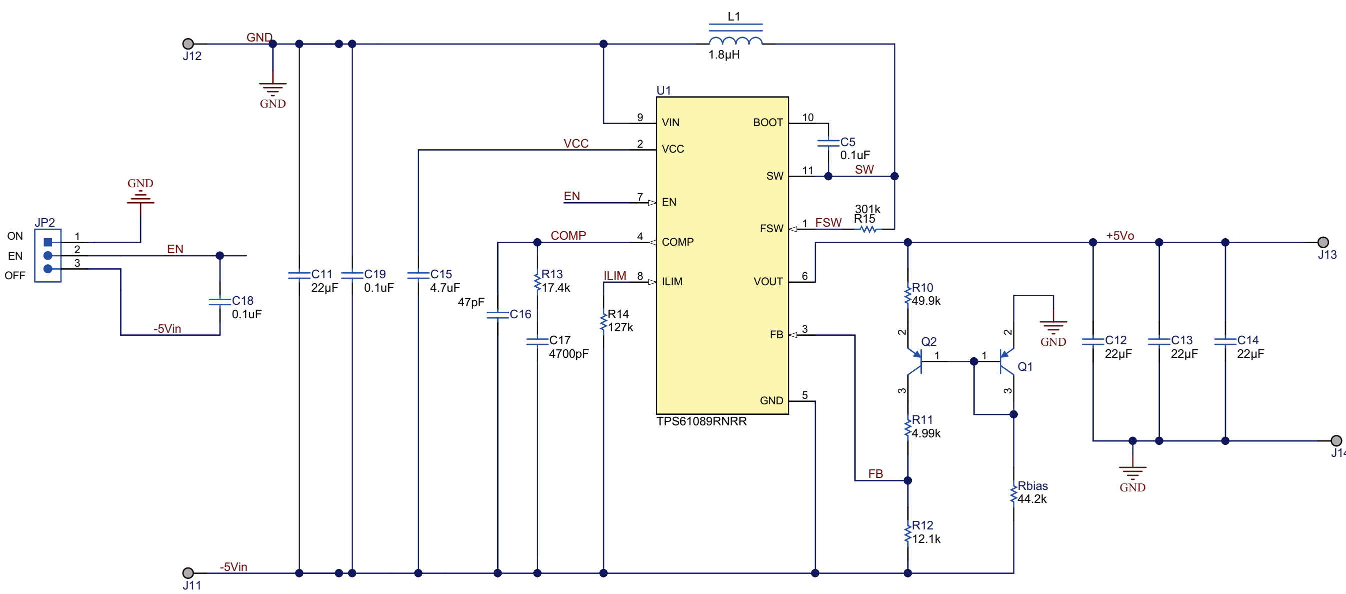


**Figure 1. TPS61088Q1EVM-037 Schematic**

## 2.2 Parameter Calculation

The emitter of Q1 is connected to the ground, the base of both transistors is one diode drop below ground. So the current flowing through Q2 can be derived by Equation 1:

$$I_{C\_Q2} = \frac{V_{OUT} + V_{BE\_Q2} - V_{BE\_Q1}}{R10} = \frac{V_{REF}}{R12} = 0.1mA \quad (1)$$

Where:

- $V_{OUT}$ is the output voltage, $V_{OUT}$ = 5 V
- $V_{BE\_Q1}$ and $V_{BE\_Q2}$ are the base to emitter voltage drop of Q1 and Q2
- $V_{REF}$ is the reference voltage of TPS61089

If the two transistors are perfectly matched to each other, then $V_{BE\_Q1}$ equals to $V_{BE\_Q2}$. The output voltage is calculated by Equation 2:

$$V_{OUT} = \frac{V_{REF} \times R10}{R12} \quad (2)$$

The $V_{BE}$ of the transistor depends on the collector current. Changing the collector current makes the $V_{BE}$ changes accordingly. If the collector current of Q1 equals to the collector current of Q2, then the $V_{BE}$ of the two transistors are well matched.

$$I_{C\_Q1} = \frac{V_{IN} + V_{BE}}{R_{BIAS}} = \frac{-5 + 0.6}{R_{BIAS}} = 0.1mA \quad (3)$$

When input voltage is -5 V, RBIAS is chosen to be 44.2 kΩ.

## 2.3 Test Result

Figure 2 through Figure 4 shows the efficiency, line regulation and load regulation curves for this application note.

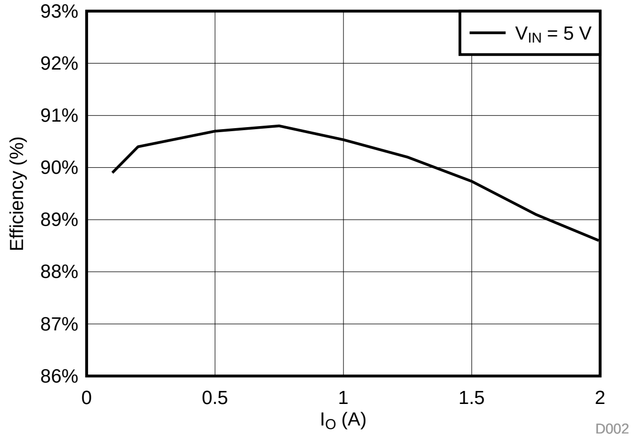


Figure 2. Efficiency vs Current

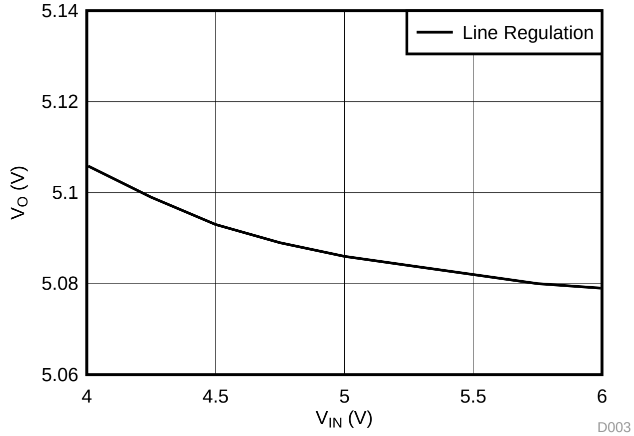


Figure 3. Line Regulation Voltage

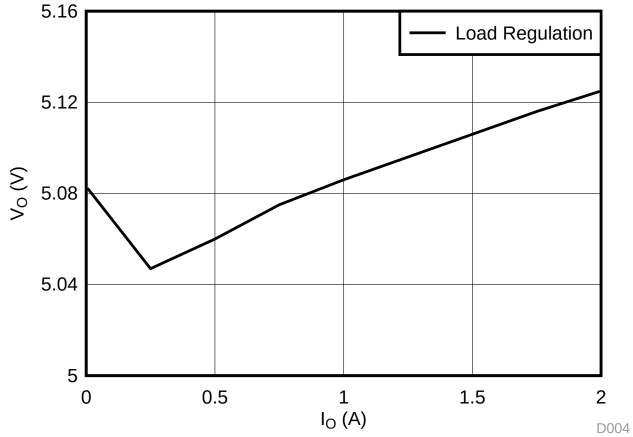


Figure 4. Load Regulation Voltage

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