

Efficiency Evaluation TPS65381-Q1

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ABSTRACT

The TPS65381 is a multi-rail power supply designed to supply microcontrollers in safety critical applications, such as those found in automotive functions. The device supports Texas Instruments' TMS570LS series 16/32-Bit RISC Flash MCU and other microcontrollers with dual-core lockstep (LS) or loosely coupled (LC) architectures .

The TPS65381 integrates multiple supply rails to power the MCU, CAN, or FlexRay, and an external sensor. An asynchronous buck switch-mode power-supply converter with an internal FET converts the input battery voltage to a 6-V pre-regulator output. This 6-V output supplies the other regulators. Furthermore, the device supports wake-up from IGNITION or wake-up from a CAN transceiver. A fixed 5-V linear regulator with internal FET is integrated as a CAN supply. A second linear regulator with an internal FET regulates the 6 V output to a selected 5-V or 3.3-V MCU IO voltage. The TPS65381 is comprised of a linear-regulator controller with external FET and resistor divider, regulating the 6 V output to an externally adjustable core voltage between 0.8 V and 3.3 V.

For more information see the TPS65381-Q1 datasheet, [SLVSBC4](#).

The efficiency of the buck and boost regulators is important for the efficiency and thermal design of the system. The results of the efficiency measurement are shown in [Section 5](#).

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1 Efficiency Test TPS65381

The efficiency of a DC-DC converter is the output power divided by the input power and typically provided as a percentage. The TPS65381 has a buck regulator, VDD6 BUCK. An external power supply, such as a car battery, supplies this buck regulator. The output of the VDD6 BUCK regulator is the supply of the regulators VDD5, VDD3/5, VDD1 and is also used to supply VSOUT1.

The standard method is used to measure the efficiency of the VDD6 BUCK regulator. This method calculates the efficiency by a standard way by measuring the input power and the output power. Because the VDD5, VDD3/5, and VDD1 regulators are supplied from VDD6 BUCK, the efficiency measurement includes the current consumption of the VDD5, VDD3/5 and VDD1. These regulators cannot be separated because the TPS65381 is a safety device. The regulators have a minimum internal-load current to ensure the stability of the regulator without external load. This load current creates a failure in the efficiency measurement of the VDD6 Buck regulator and results in a lower efficiency than when the VDD6 BUCK regulator measured without internal load.

2 Efficiency Test Setup

2.1 Efficiency Test Setup VDD6 BUCK

Figure 1 shows the test set up.

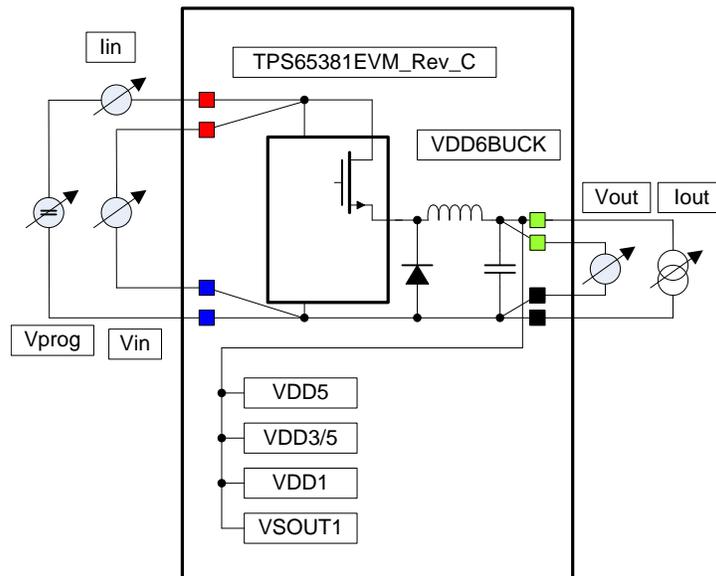


Figure 1. Efficiency Test Setup for VDD6 BUCK

3 The Test Flow

In order to perform the test, the device is placed on the TPS65381EVM (see the EVM user's guide, [SLVU847](#)).

An external lab supply, V_{prog} , supplies the board and DUT. The input current is measured with an ammeter I_{in} . To ensure the correct input voltage measurement an additional voltmeter is used to measure V_{in} .

A source meter creates the load current I_{out} . While another voltmeter the output voltage measures V_{out} .

While changing the output load current I_{out} from 0 to the maximum current (1.3 A), the input voltage (V_{in}), the input current (I_{in}), and the output voltage (V_{out}) are measured. Out of the measurement results the efficiency was calculated for every operation point. The efficiency was tested at three different input voltages for V_{prog} : 7 V, 13.8 V, and 28 V.

Figure 2 shows the test results.

4 Application Data Overview

Board		TPS65381EVM_Rev_c
Vprog		7 V 13.8 V 28 V
Temperature		Room temperature at approximately 25°C
VDD6 Buck	Vout	6 V
	Iload	0 A to 1.3 A
VDD5	Vout	5 V
	Iload	0 A
VDD3/5	Vout	5 V
	Iload	0 A
VDD1	Vout	1.8 V
	Iload	0 A
VSOUT1	Vout	5 V
	Iload	0 A

5 Test Results

5.1 VDD6 BUCK Efficiency

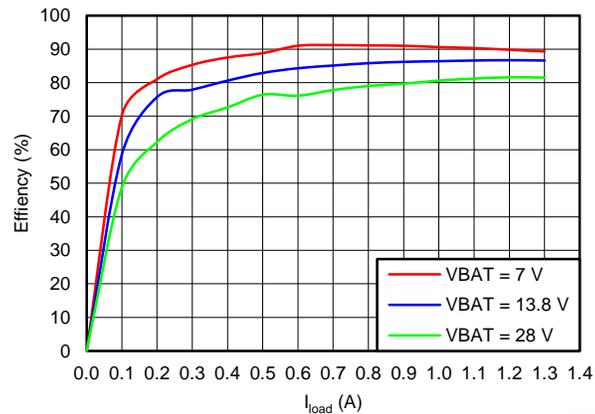


Figure 2. Efficiency Results VDD6 BUCK

6 Efficiency Test Summary

The efficiency tests of the VDD6 BUCK regulator as part of the TPS65381 device was performed with the following results:

- The buck regulator has an efficiency of 86% at a nominal operation point (Vprog = 13.8 V, Iload = 75% of Imax = 1A).
 - The real efficiency is higher because the VDD6 regulator is the supply of low-dropout regulators (LDOs). These LDOs cannot turn off and always use some load current which is not taken into consideration with this test.

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