Application Report
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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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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, VDD1and 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 byandard way by measuring the input power and the output power. Because the VDD5, VDD3/5, and VDD1 regulatores 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.

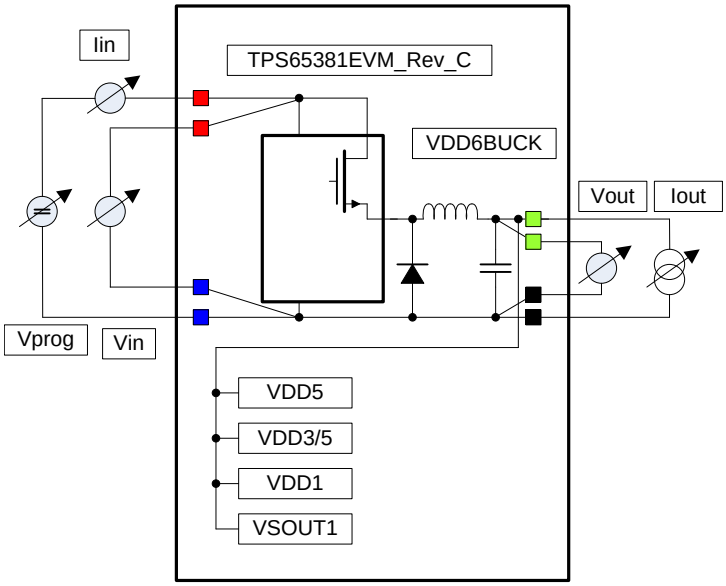

Figure 1. Efficiency Test Setup for VDD6 BUCK

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, Vprog, supplies the board and DUT. The input current is measured with an ammeter Iin. To ensure the correct input voltage measurement an additional voltmeter is used to measure Vin.

A source meter creates the load current Iout. While another voltmeter the output voltage measures Vout.

While changing the output load current Iout from 0 to the maximum current (1.3 A), the input voltage (Vin), the input current (Iin), and the output voltage (Vout) 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 Vprog: 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

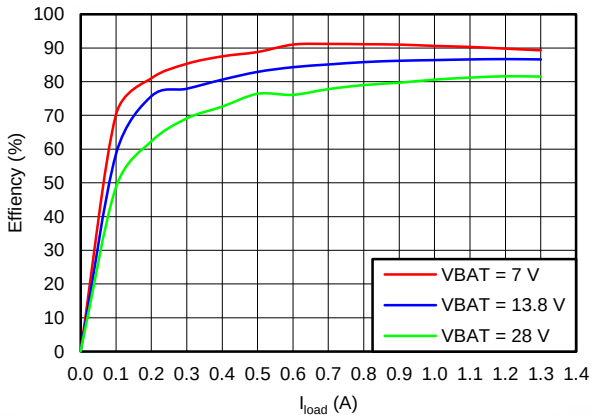

Figure 2. Efficiency Results VDD6 BUCK

6 Efficency 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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