TPS65310A-Q1 Efficiency

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ABSTRACT

The TPS65310A-Q1 device is a power management unit that meets the requirements of DSP-controlled automotive systems (Advanced Driver Assistance Systems). The device integrates commonly-used features, which reduces board space and system costs.

The device includes one high-voltage buck controller for pre-regulation, and two buck controllers and one boost converter for post-regulation. A further integrated low-dropout regulator (LDO) rounds up the power-supply concept and offers a flexible system design with five independent voltage rails. The device offers a low-power-state LPM0 with all rails turned off to reduce current consumption in case the system is constantly connected to the battery line. All outputs are protected against overload and over temperature. An external PMOS allows the device to sustain voltage transients up to 80 V as a protection feature. This external PMOS protects the system in safety-critical applications if a rail shows a malfunction (undervoltage, overvoltage, undercurrent, or overcurrent). Internal soft start ensures controlled startup for all supplies. Each power supply output has an adjustable output voltage based on the external resistor network settings. For more information, see the TPS65310A-Q1 data sheet, SLVSC15.

The efficiency of the buck and boost regulators is important for the efficiency and thermal design of the system. This application report shows efficiency measurement results.

Contents

1 Efficiency Test of TPS65310A-Q1

The efficiency of a DC-DC converter is the output power divided by the input power and is typically represented as a percentage. The TPS65310A-Q1 device has a pre-buck regulator, Buck1. This external power supply (car battery) supplies the buck regulator. The output of the Buck1 regulator is the supply of the regulators Buck2, Buck3, BOOST, and LDO.

The standard method is used to measure the efficiency of the Buck1 regulator. This method calculates the efficiency by the standard way of measuring the input power and the output power. Because the Buck2, Buck3, BOOST, and LDO are supplied from Buck1, more effort is required to measure input power. Buck2, Buck3, BOOST, and LDO cannot be separated because the TPS65310A device is a safety device and monitors to correct the function of all regulators. If one regulator shows a failure, the device will try to start-up seven times, but because of failure, the device ends in LPM0 state. For more details, please see the TPS65310A-Q1 data sheet.

2 Efficiency Test Setup

To perform the test, the device is placed on the TPS65310AEVM (see the EVM user's guide, SLVU912).

2.1 Efficiency Test Setup of Buck1

An external lab supply, V_{PROG}, supplies the board and device under test (DUT). The input current is measured with an ammeter I_{IN}. An additional voltmeter measures V_{IN} to ensure the correct input voltage measurement.

A source meter creates the load current I_{OUT}. Another voltmeter measures the output voltage V_{OUT}.

The efficiency of the input and output power was calculated using V_{IN}, I_{IN}, V_{OUT}, and I_{OUT}.
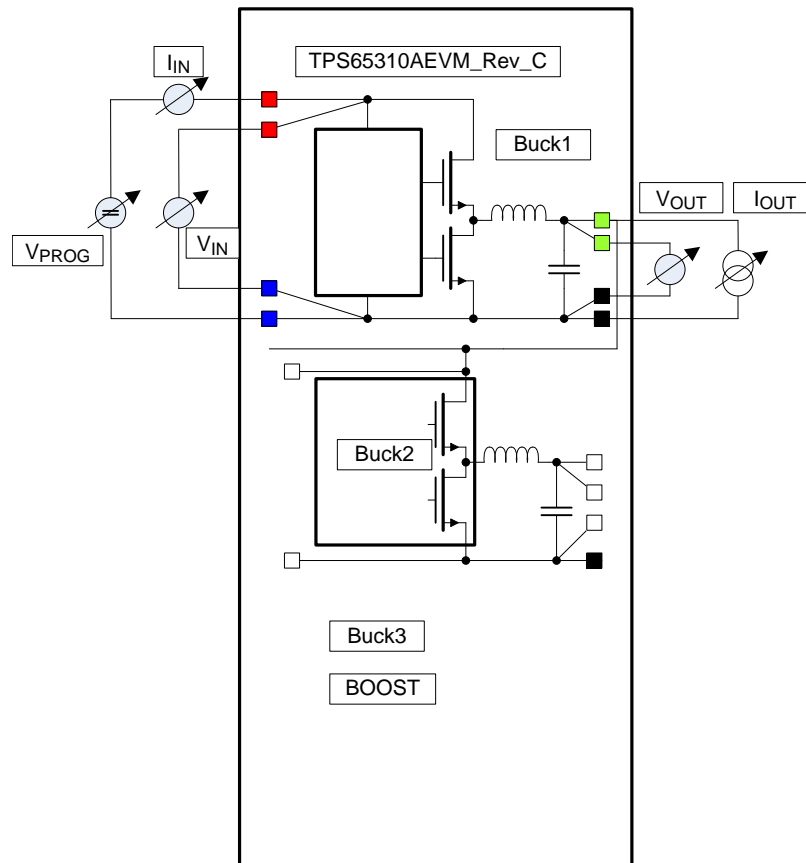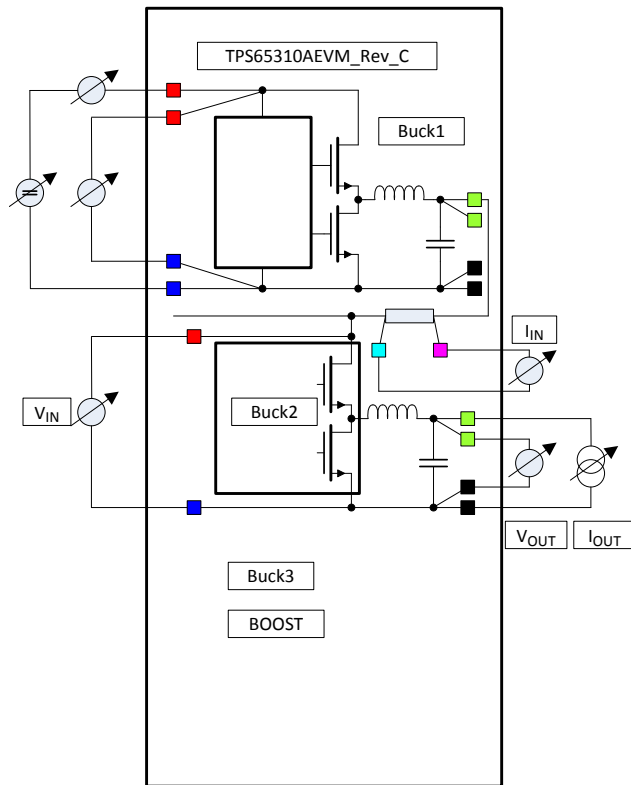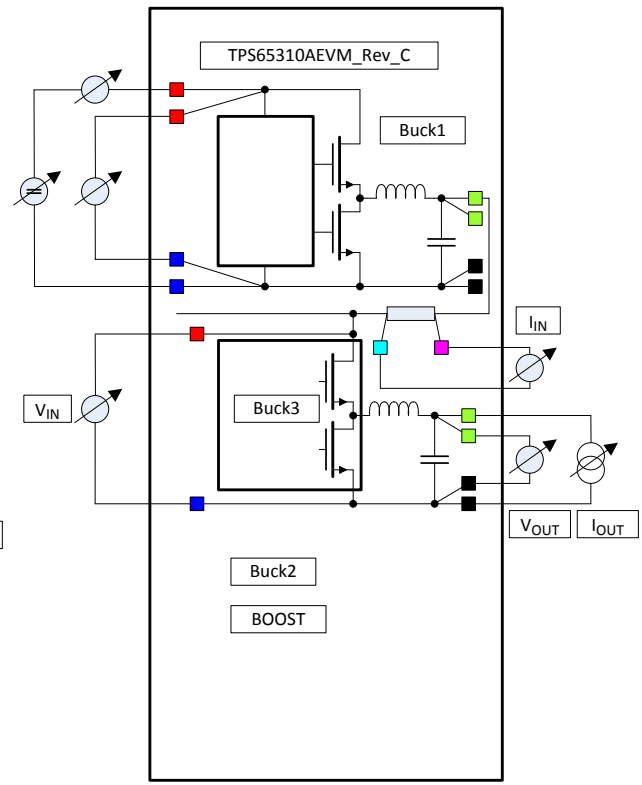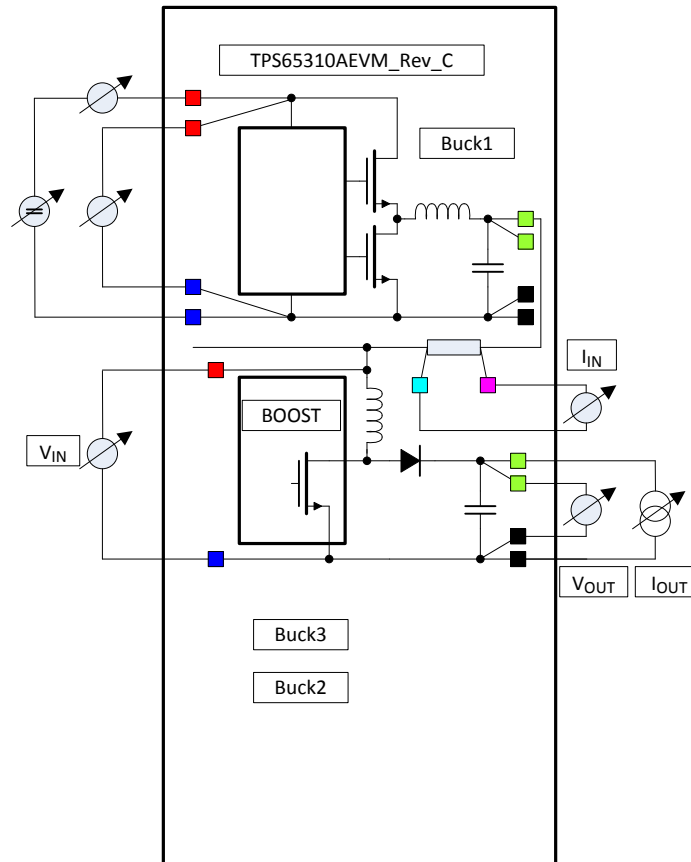

Figure 1. Efficiency Test Setup of Buck1

2.2 *Efficiency Test Setup of Buck2 and Buck3*

An external lab supply, V_{PROG}, supplies the board and DUT. The input currents of Buck2 and Buck3 were measured with a voltmeter across a shunt resistor and I_{IN} was calculated. An additional voltmeter measures V_{IN} to ensure the correct input voltage measurement (see Figure 2 and Figure 3).

A source meter created the load current I_{OUT}. Another voltmeter measured the output voltage V_{OUT}.

The efficiency of the input and output power was calculated using the V_{IN}, I_{IN}, V_{OUT}, and I_{OUT}.

Figure 2. Efficiency Test Setup of Buck2

Figure 3. Efficiency Test Setup of Buck3

2.3 *Efficiency Test Setup of BOOST*

An external lab supply, V_{PROG}, supplies the board and DUT. The input current of BOOST was measured with an voltmeter across a shunt resistor and I_{IN} was calculated. An additional voltmeter measured V_{IN} to ensure the correct input voltage measurement (see Figure 4).

A source meter created the load current I_{OUT}. Another voltmeter measured the output voltage V_{OUT}.

The efficiency of the input and output power was calculated using the V_{IN}, I_{IN}, V_{OUT}, and I_{OUT}.

Figure 4. Efficiency Test Setup of BOOST

3 Application Data

Board		Used board: TPS65310AEVM_Rev_C
Buck 1	VBAT	5 V, 8.1 V, 10 V, 14 V, 18 V, 22 V, 26 V, 30 V, 34 V, 36 V, 37 V
	V_{OUT}	3.8 V
	I_{Load}	0 to 2.5 A
Buck 2	VBAT	13.8 V
	V_{OUT}	3.3 V
	I_{Load}	0 to 2.4 A
Buck 3	VBAT	13.8 V
	V_{OUT}	1.2 V
	I_{Load}	0 to 2.4 A
BOOST	VBAT	13.8 V
	V_{OUT}	5 V
	I_{Load}	0 to 0.3 A

4 Test Results

4.1 Buck1 Efficiency
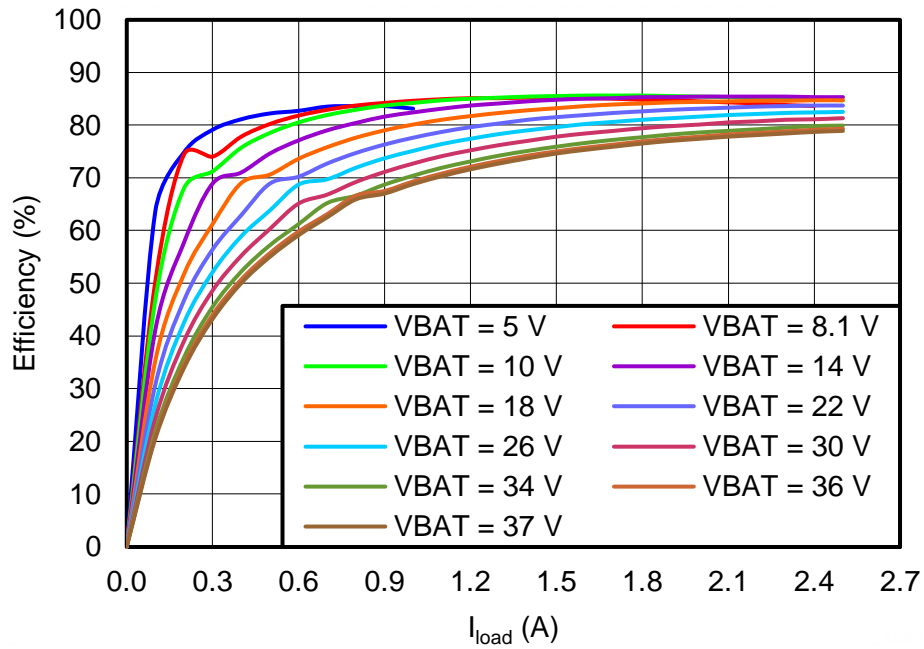
Figure 5. Efficiency Results of Buck1

4.2 Buck2 Efficiency
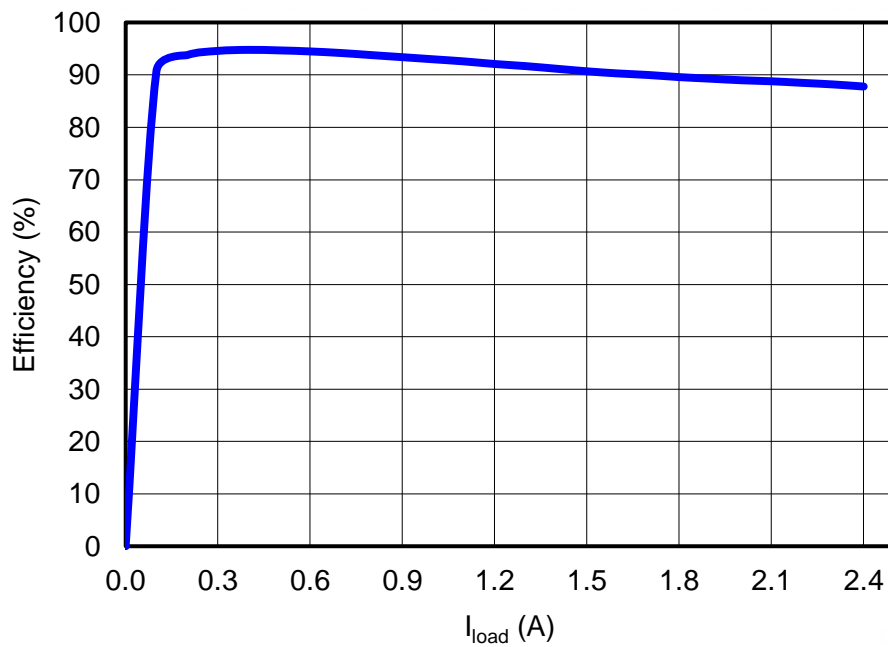
Figure 6. Efficiency Results of Buck2

4.3 Buck3 Efficiency
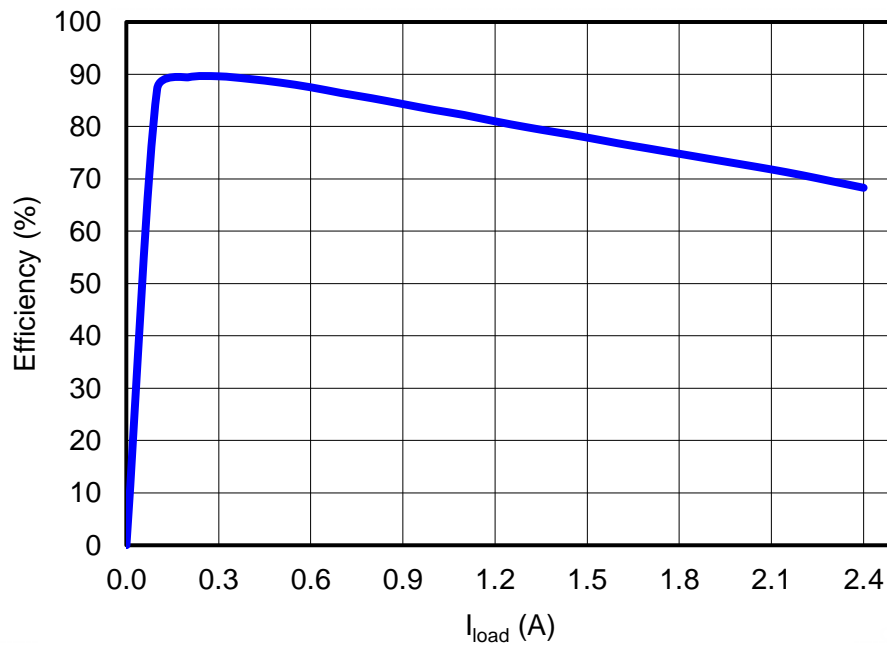
Figure 7. Efficiency Results of Buck3

4.4 BOOST Efficiency
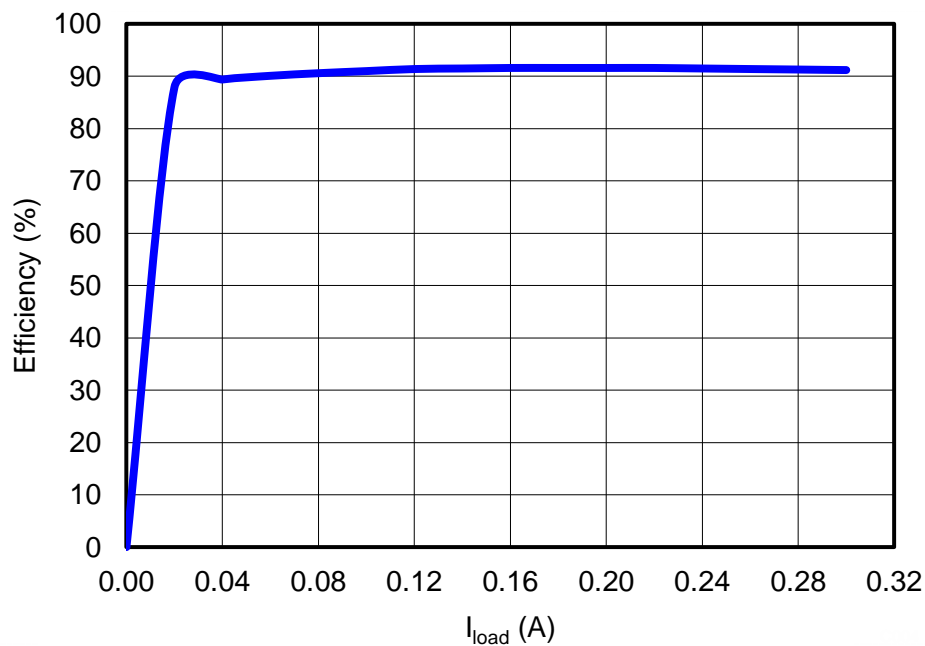
Figure 8. Efficiency Results of BOOST

5 Efficiency Test Summary

The efficiency of the TPS65310A-Q1 device was measured with the device placed on the TPS65310EVM. The device operated within the specified supply-voltage range and specified load range. Results for every convertor are shown in the preceding diagrams.

Revision History

Changes from Original (October 2013) to A Revision   **Page**

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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