Application Report
SLVA361–August 2009

0.7-V to 3.3-V Input, 3.3-V Output, High-Efficiency DC/DC Converter

PMP - DC/DC Low-Power Converters

ABSTRACT

This design was created to help those desiring to design-in a Stellaris® ARM® Cortex™-M3 MCU into a system requiring a very low-input voltage range and is concerned about maintaining high efficiency and long battery life. This particular design allows for an input voltage between 0.7V to 3.3V.

1 Features

- 0.7 V to 3.3 V input voltage range
- Fixed 3.3-V output eliminates need for external voltage-setting resistors
- TPS61221 is capable of driving up to 200 mA
- High efficiency (up to 92%)
- Low-quiescent current (less than 5.5 µA)
- Tiny SC-70 package

2 Introduction

This reference design is for the Stellaris® ARM® Cortex™-M3 MCU devices and accounts for voltage and current, requirements given below. The Stellaris® devices only require a single 3.3V input, so no sequencing is required. The operating input voltage for this reference design is 0.7V to 3.3V. This design is optimized for very-low input voltage range and small design/low part count.

3 Requirements

The power requirements for each Stellaris® ARM® Cortex™-M3 MCU family are listed below.

For more information and other reference designs, please visit www.ti.com/processorpower.

Table 1. Stellaris® ARM® Cortex™-M3 MCU Family Power Requirements

DEVICE FAMILY	PIN NAME	VOLTAGE (V)	I_{MAX} (mA)	TOLERANCE	SEQUENCING ORDER	TIMING DELAY	COMMENTS
LM3S100 series LM3S300 series LM3S600 series LM3S800 series LM3S1000 series LM3S2000 series LM3S3000 series LM3S5000 series	VDD	3.3	170	±10%	—	—	Internal regulator supplies power to device core
LM3S6000 series LM3S8000 series	VDD	3.3	225	±10%	—	—	Internal regulator supplies power to device core
LM3S9000 series	VDD	3.3	150	±10%	—	—	Internal regulator supplies power to device core
LM3S2B93, LM3S2B2793, LM3S5B91, LM3S5791	VDD	3.3	100	±10%	—	—	Internal regulator supplies power to device core
Note: The "Imax" currents listed are worst case expected values.							

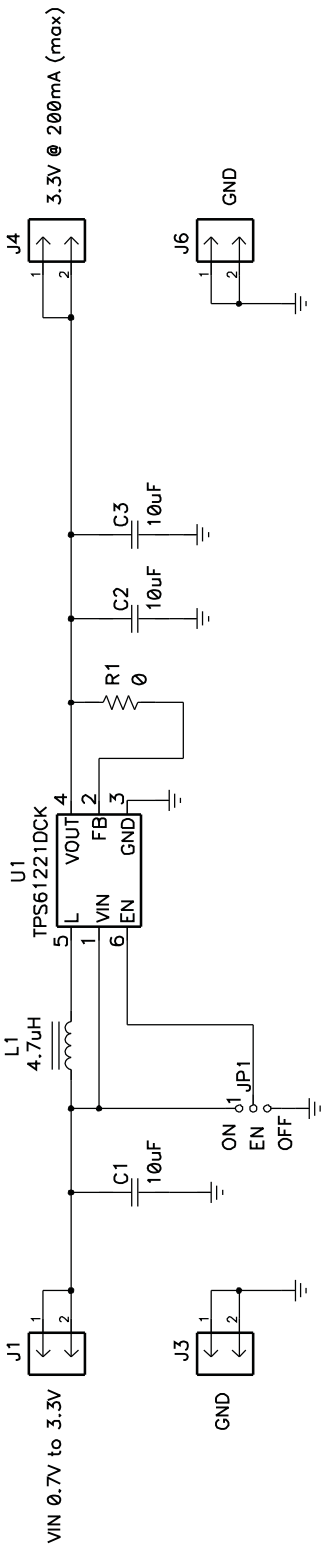

Figure 1. PMP4776 Reference Design Schematic

4 List of Materials

Table 2. PMP4776 List of Materials

REF DES	QTY	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
C1, C2, C3	3	10 µF	Capacitor, ceramic, 6.3 V, X5R, 20%	0603	GRM188R60J106ME84	muRata
L1	1	4.7 µH	Inductor, SMT, 550 mA, 145 mΩ	0.08" x 0.08"	EPL3015-472ML	Coilcraft
R1	1	0	Resistor, chip, 1/16W, 1%	0603	Std	Std
U1	1		IC, Tiny low-input voltage boost converter	SC-70	TPS61221DCK	TI

5 Test Results

5.1 Startup

The input and output startup waveforms are shown in the figure below after the application of V_{IN}. In Figure 2, the input voltage was set to 1.2 V and the 3.3 V output was loaded to 70 mA. In Figure 3 the input voltage was set to 1.2 V and the 3.3-V output was loaded to 0 mA. In Figure 4 The input voltage was set to 2.4 V and the 3.3-V output was loaded to 168 mA. In Figure 5 the input voltage was set to 1.2 V and the 3.3-V output was loaded to 0 mA. (V_{IN} is 1 V/div, V_{OUT} is 1 V/div. Timing is 1 md/div).

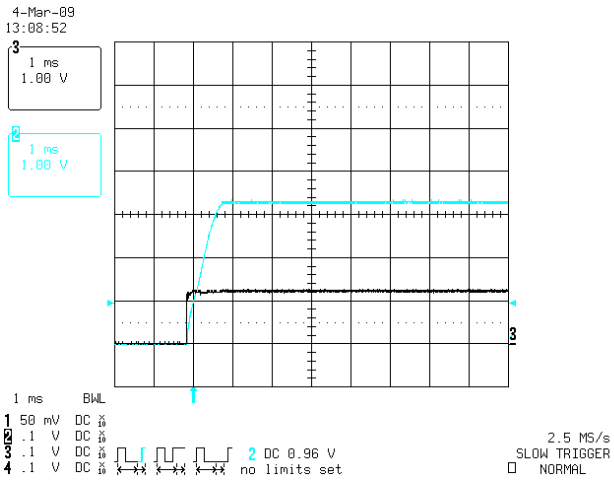

Figure 2. Startup

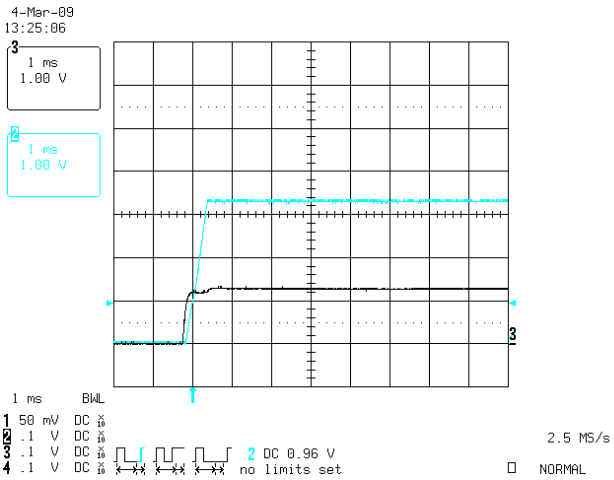

Figure 3. Startup

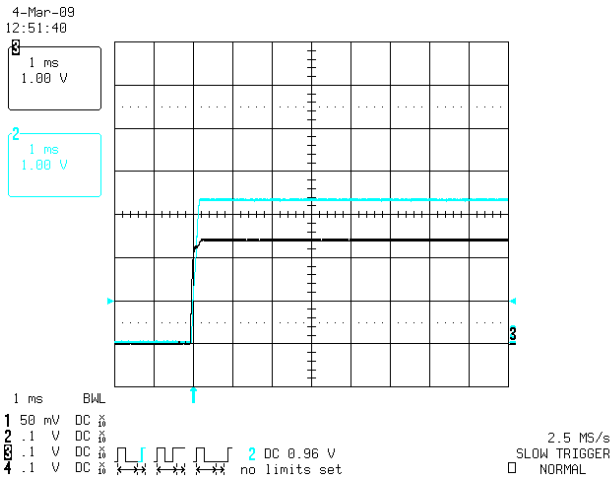

Figure 4. Startup

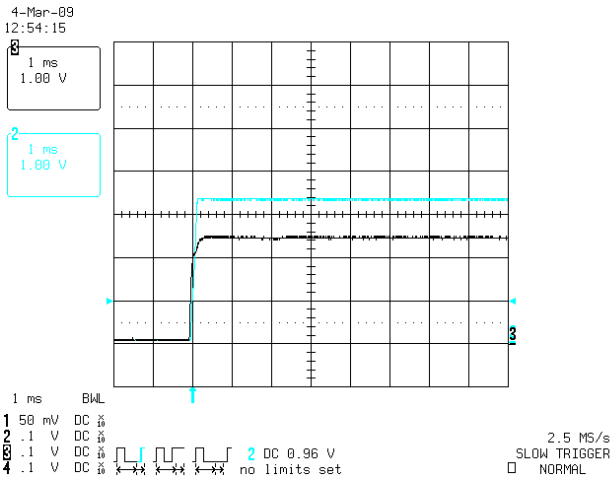

Figure 5. Startup

5.2 Ripple

The 3.3-V output ripple voltage is shown in the figures below . In Figure 6, the image was taken with the input voltage set to 1.2 Vdc and the output loaded to 70 mA. In Figure 7, the image was taken with the input voltage set to 2.4 Vdc and the output loaded to 168 mA. (20 m V/div, timing 2 µs/div).

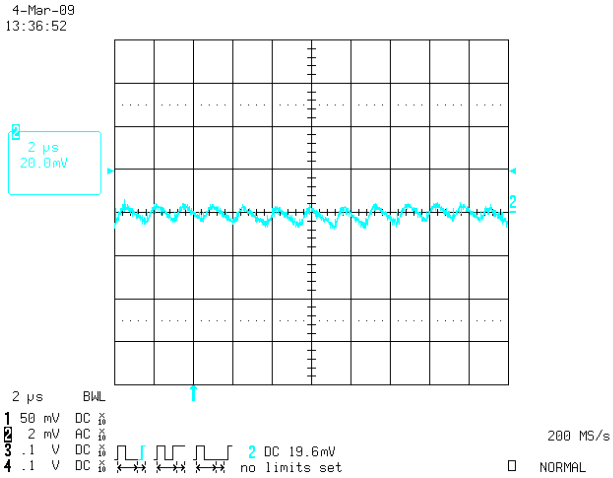

Figure 6. Output Ripple Voltage, V_{IN} = 5 V

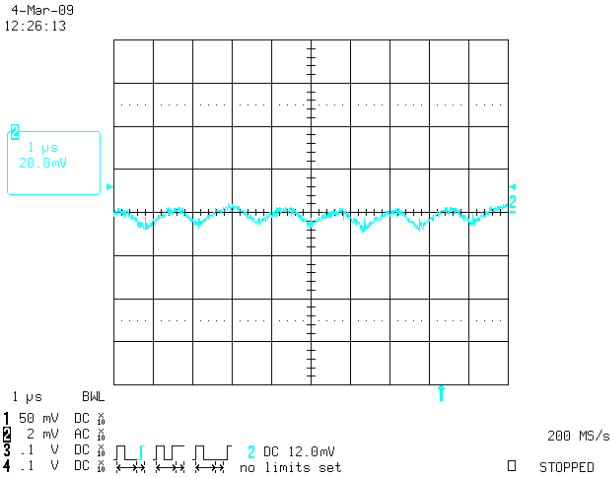

Figure 7. Output Ripple Voltage, V_{IN} = 12 V

5.3 Load Transient

Figure 8 shows the 3.3-V output voltage when the load current is stepped between 35 mA and 65 mA. V_{IN} = 1.2 Vdc. (20 mV/div, 50 mA/div, 10 ms/div). Figure 9 shows the 3.3-V output voltage when the load current is stepped between 100 mA and 175 mA. V_{IN} 2.4Vdc. (20 mV/div, 100 mA/div, 2 ms/div)

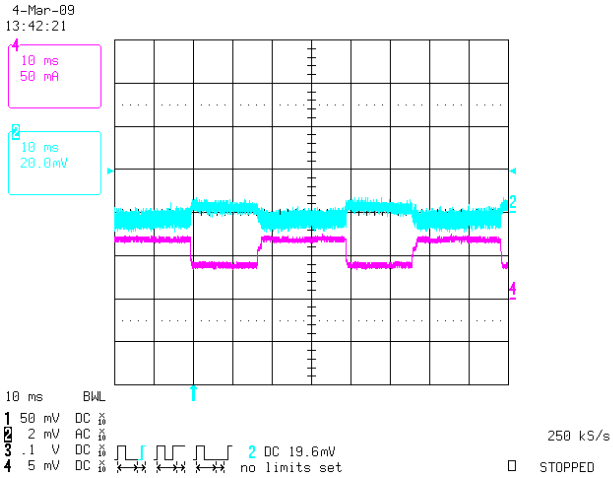

Figure 8. Load Transient

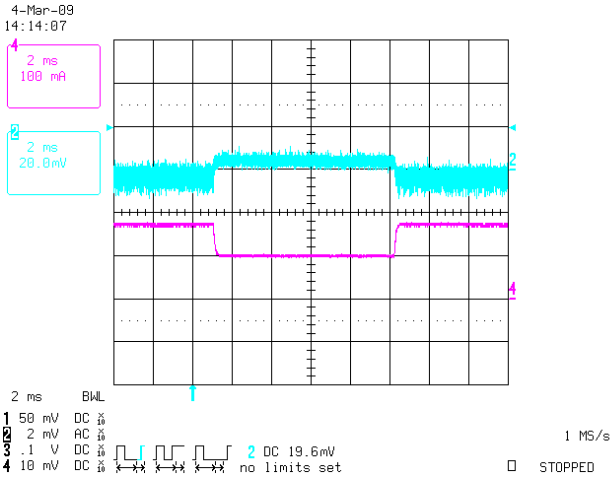

Figure 9. Load Transient

5.4 Switching Node

The switching node waveform is shown in Figure 10 with a 2.4-V input voltage and 168-mA load. (V_{OUT} is 2 V/div, timing is 1 µs/div) .

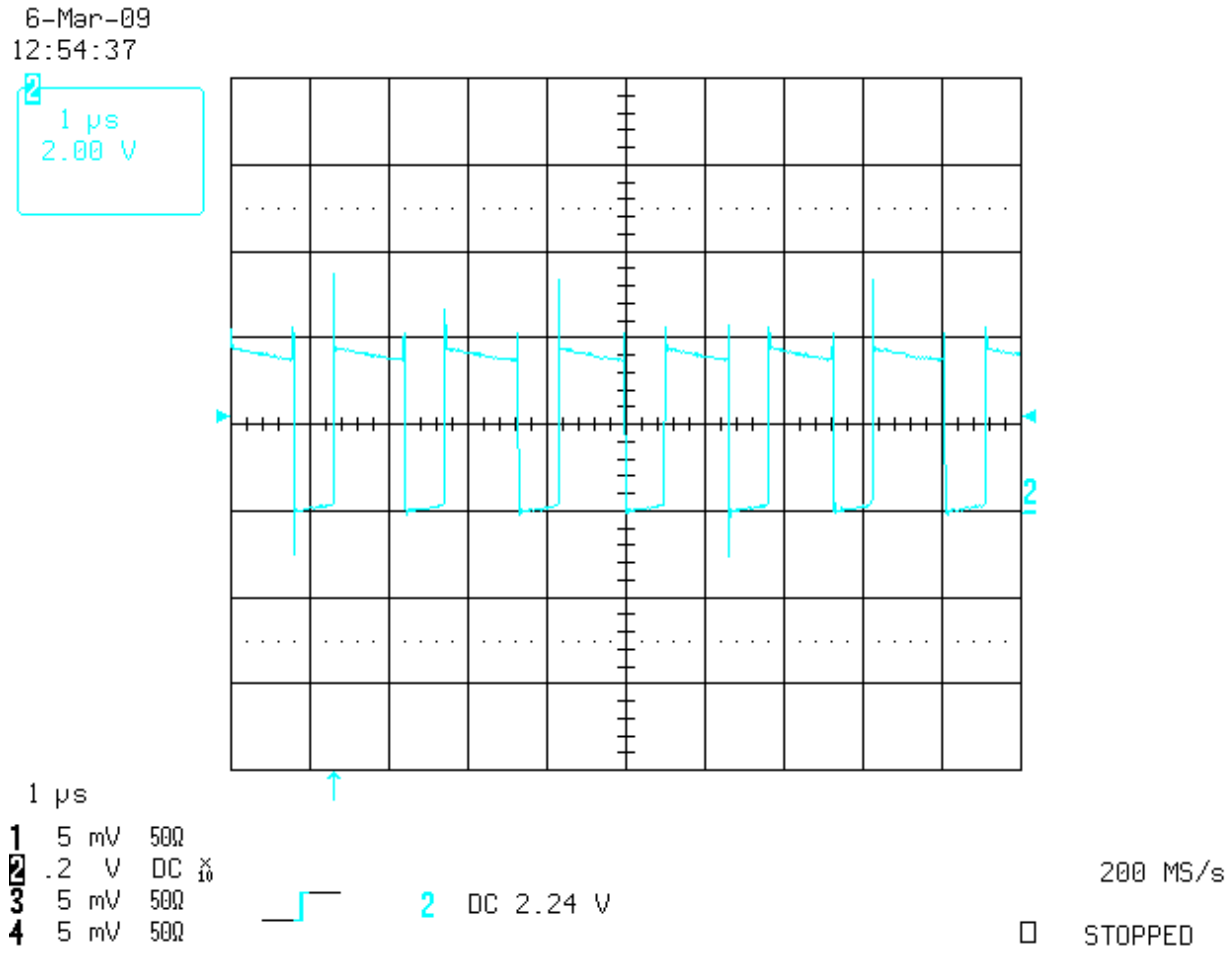

Figure 10. Switching Node Waveform, 2.4V Input Voltage and 168mA Load

5.5 Efficiency

The TPS61221 converter efficiency is shown in .

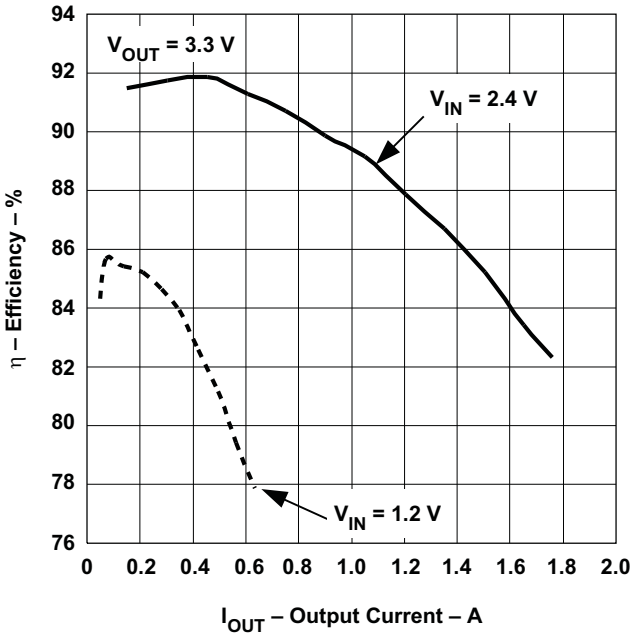

Figure 11. TPS61221 Efficiency

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