Application Report
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Powering VCCINT_VCU Rail in the Xilinx® Zynq®UltraScale+™ Family of Multiprocessors

Yann Ducommun

ABSTRACT

In the Xilinx® Zynq®UltraScale+™ family of multiprocessor systems-on-chip (MPSoC), the highly integrated -EV devices are designed for applications requiring high definition video and feature an embedded high performance video codec unit (VCU). The VCU needs to be powered by an independent 0.9-V internal supply rail named VCCINT_VCU. This short technical note is an extension to the reference guide for Integrated Power Supply Reference Design for Xilinx® Zynq® UltraScale+™ ZU5EV and Artix® 7 FPGAs and discusses low power buck converters to power the VCCINT_VCU rail depending on the requirements of the end application.

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1 Introduction

In the Integrated Power Supply Reference Design for Xilinx® Zynq® UltraScale+™ ZU5EV and Artix® 7 FPGAs, the system input power source is DC 5-V, provided by a YU0506, 30-W 5-V 6-A AC/DC Power Adapter. For the VCCINT_VCU rail, this input voltage needs to be regulated down to 0.9-V (±3%) and sustain a current ranging from 500-mA up to 3-A depending on the complexity of the video processing tasks in the end application.

Table 1. Key Specification Relevant for the VCCINT_VCU Rail

Parameter	Specifications	Details
Input power source	DC 5-v, 6-1 (30-W)	YU506
VCCINT_VCU	0.9-V, ±3%, up to 3-A	Independent rail for -EV product variants

2 Proposed Solution

To provide flexibility and scalability in designing the VCCINT_VCU power rail for a wide variety of performance requirements, this technical note discusses solutions based on pin-to-pin compatible families of products able to deliver output currents ranging from 1/2-A up to 4-A, which can be selected and easily substituted according to the needs of the system, even at a late point in the design process.

The following sections concentrate on describing two highly efficient, solution-size optimized DC/DC converter families with focus on improving light load efficiency and transient response speed as shown in Section 2.1, or controlling and/or filtering out switching noise as shown in Section 2.2.

2.1 Light Load Efficiency and Fast Transient Response

Texas Instruments DCS-Control topology is an advanced DC/DC converter architecture that combines the advantages of hysteretic and voltage mode control in order to provide excellent DC-voltage and load-transient regulation, low output voltage ripple, and a seamless transition from pulse-width modulation (PWM) to Power Save Mode (PSM) operation as shown in *High-efficiency, low-ripple DCS-Control™ offers seamless PWM/power-save transitions article*. DCS-Control devices, like the TPS6282X *TPS6282x, 2.4-V to 5.5-V input, 2-, 3-, 4-A step-down converter with 1% output accuracy in 1.5-mm × 1.5-mm QFN package data sheet*, can support applications where highest efficiency is required over a large output current range, and excellent transient response is required to cleanly power dynamic loads in processors, like for example the VCCINT_VCU rail.

The TPS6282X is a 2.4-V to 5.5-V input step-down converter pin-to-pin family featuring output currents ranging from 1/2-A to 4-A and available in a 1.5-mm x 1.5-mm QFN package. Some device versions include an automatically entered power save mode (PSM) to maintain high efficiency down to very light loads for extending the system battery runtime. The internal reference allows regulating the output voltage with a high feedback voltage accuracy of 1% over the junction temperature range of –40°C to 125°C.

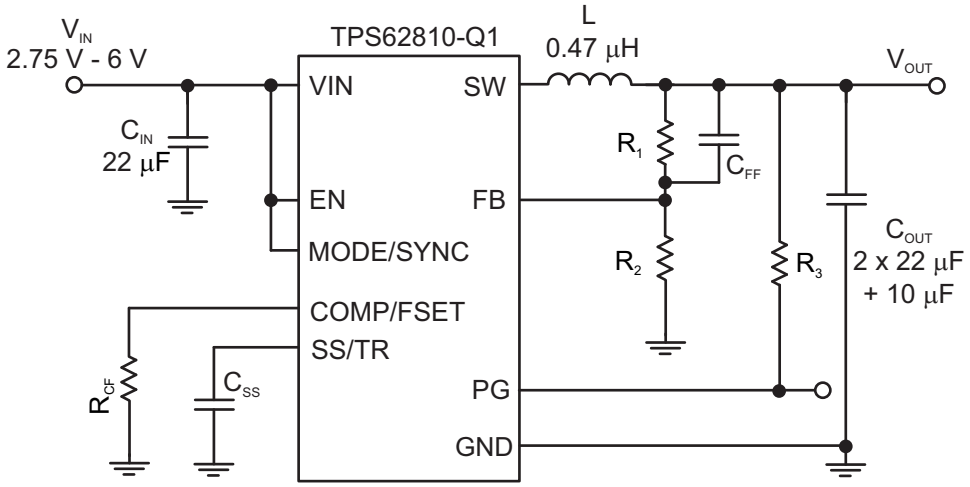

Figure 1. Typical TPS6282X Application Circuit

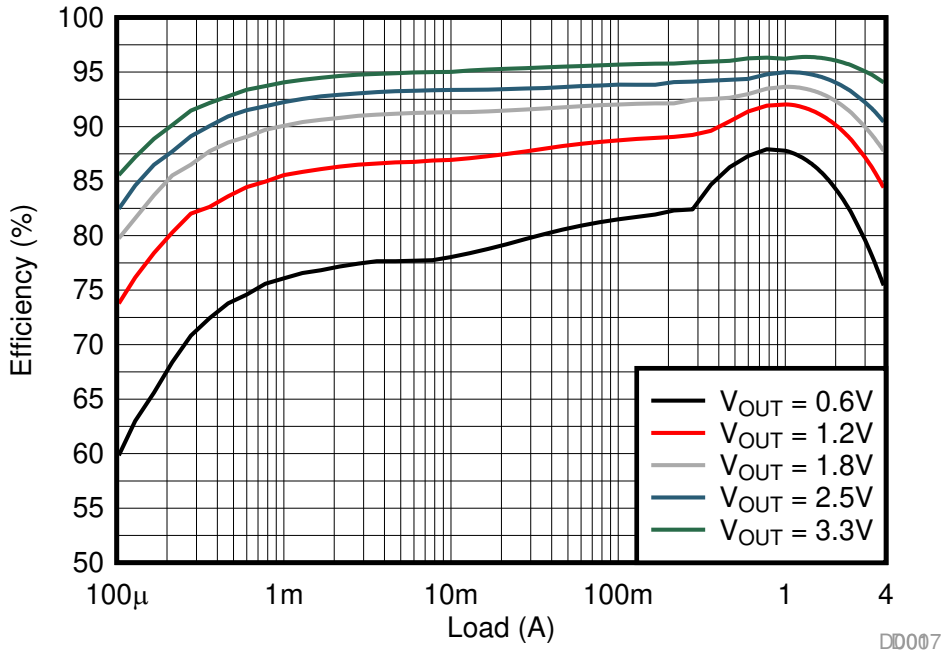

Figure 2. Efficiency vs. Load at VIN=5V

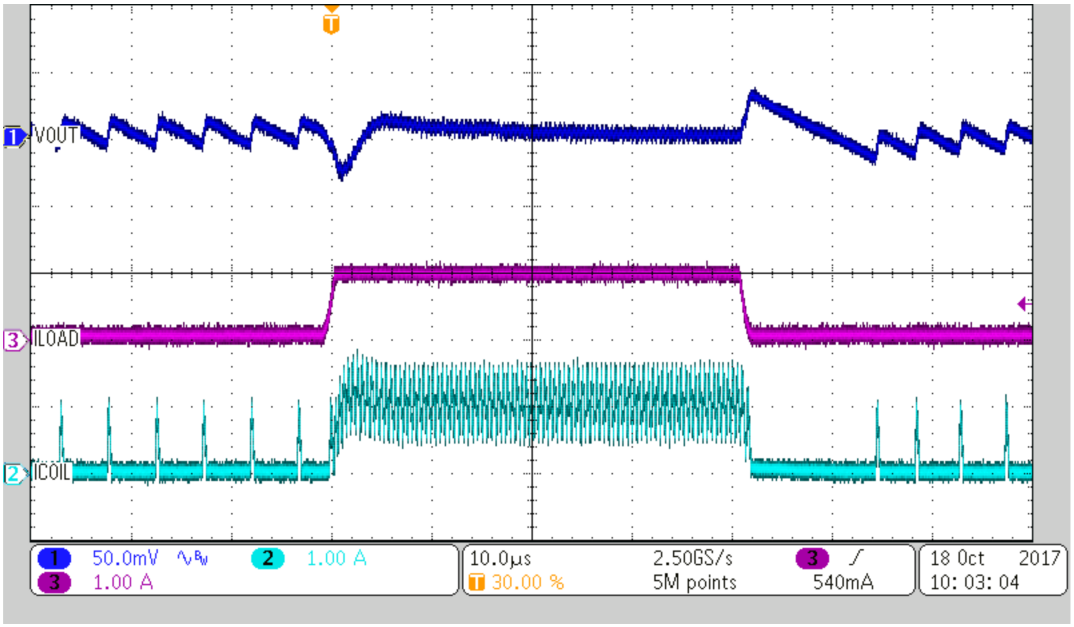

Figure 3. Load transient Performance with I_{out} = 0.05A to 1A

2.2 Fixed Frequency and Noise Control

In some applications, it may be desirable to best control the switching noise produced by the DC/DC converter, To keep it out of system-critical frequencies, for example, the AM radio band, or facilitate its filtering. While some versions of the TPS6282X family support forced PWM operation at light load, the DCS-Control™ topology is non-oscillator-based and its switching frequency can vary with changes in the application conditions as shown in *Understanding frequency variation in the DCS-Control™ topology article*. For noise control optimization, a fixed switching frequency topology DC/DC converter, similar to the TPS6281X as shown in *TPS6281x-Q1 2.75-V to 6-V Adjustable-Frequency Step-Down Converter data sheet*, can be the better choice to power VCCINT_VCU.

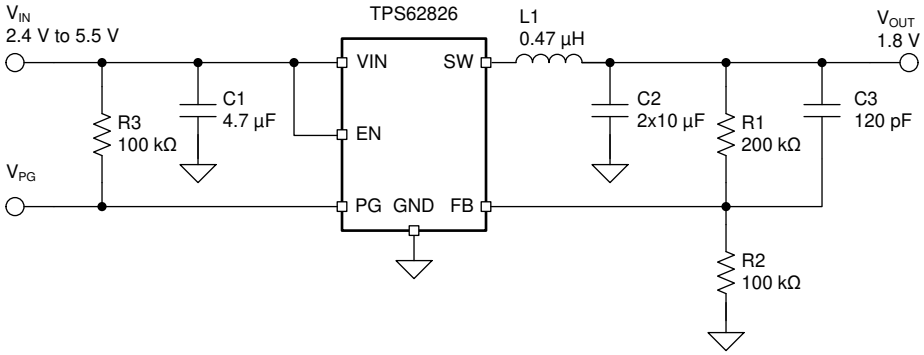

Figure 4. Typical TPS6281X Application Circuit

Table 2. Switching Frequency Settings Example Table for TPS62810-Q1

RCF	Switching frequency	Min count (V_{out} <1 V)
10kΩ to 4.5kΩ	1.8MHz (10kΩ) to 4MHz (4.5kΩ)	53µF
33kΩ to 15kΩ	1.8MHz (33kΩ) to 4MHz (15kΩ)	100µF
100kΩ to 45kΩ	1.8MHz (100kΩ) to 4MHz (45kΩ)	200µF
tied to GND	Internally fixed at 2.25 MHz	53µF
tied to VIN	Internally fixed at 2.25 MHz	200µF

The TPS6281X is 2.75-V to 6-V input step-down converter pin-to-pin family supporting output currents ranging from 1-A to 4-A and available in a 3-mm x 2-mm VQFN package. The switching frequency is fixed and externally adjustable from 1.8-MHz to 4-MHz using a RCF resistor connected to the COMP/FSET pin. It can also be synchronized to an external clock in the same frequency range. The feedback voltage accuracy is specified to 1% over the whole junction temperature range of –40°C to 150°C.

3 Summary

We have presented two highly efficient, size-optimized low power buck converter solutions to power the VCCINT_VCU rail of the –EV devices from the Xilinx® Zynq®UltraScale+™ family of MPSoC.

Each proposed solution consists of a pin-to-pin family of DC/DC converters covering a large span of output currents, allowing flexibility in the application design.

The TPS6282X family focuses on optimizing light load efficiency and load transient behavior, while the TPS6281X family enables efficient noise control and filtering in sensitive application through fixed frequency operation.

4 References

- Texas Instruments, *Integrated Power Supply Reference Design for Xilinx Zynq® UltraScale+™ ZU2CG−ZU5EV MPSoCs*
- Texas Instruments, *High-efficiency, low-ripple DCS-Control™ offers seamless PWM/power-save transitions article*
- Texas Instruments, *TPS6282x, 2.4-V to 5.5-V input, 2-, 3-, 4-A step-down converter with 1% output accuracy in 1.5-mm × 1.5-mm QFN package data sheet*
- Texas Instruments, *Understanding frequency variation in the DCS-Control™ topology article*
- Texas Instruments, *TPS6281x-Q1 2.75-V to 6-V Adjustable-Frequency Step-Down Converter data sheet*

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265