Application Note

TPSM8A29 Fast Load Transient with DCAP-3

ABSTRACT

Whether it is ensuring stable high bandwidth data communications or meeting the stringent needs of an automated tester, hardware developers today are challenged with increasing load transient requirements, short development cycles, and limited space. To address these concerns, this application note demonstration showcases the benefits of using a D-CAP3, constant-on-time-based buck switching regulator over a fixed frequency-based buck switching regulator. The TPSM8A29 uses DCAP-3 control and the TPS543B20 uses fixed frequency control. DCAP-3 delivers faster load transient response versus fixed frequency control for the same load transients.

Table of Contents

List of Figures

List of Tables

Trademarks

1 Overview

To showcase how TPSM8A29 offers better transient performance than its fixed frequency counterpart (TPS543B20), both devices were set up using the same external components.

Table 1-1. Design Specifications

Initial Design	TPSM8A29	TPS543B20
Output Voltage	0.9 V	0.9 V
Switching Frequency	600 kHz	500 kHz
Input Capacitance	330-µF + 4 x 22-µF	330-µF + 4 x 22-µF
Inductor	0.6 µH (integrated)	0.6 µH
Output Capacitance	2 x 100-µF	2 x 100-µF
Load Transient	5 A - 13 A, at 4 A/µs step	5 A - 13 A, at 4 A/µs step
Transient Voltage pk-pk	84 mV	114 mV

One difference to note here is that the TPSM8A29 module switching frequency setting is 600 kHz and is measured at 614 kHz, whereas The TPS543B20 converter switching frequency setting is 500 kHz and is measured at 550 kHz.

2 Results

During the load transient, the TPSM8A29 achieves an 84 mV peak-to-peak voltage transient with only 42 mV zero-to-peak (Figure 2-1) during the unload transient. The DCAP-3 control architecture featured in TPSM8A29 allows for a higher crossover frequency and lower overall output capacitance. Additionally, when the load is turned off, TPSM8A29 does not begin switching until the entire load has dropped to zero, minimizing the peak voltage to 40 mV.

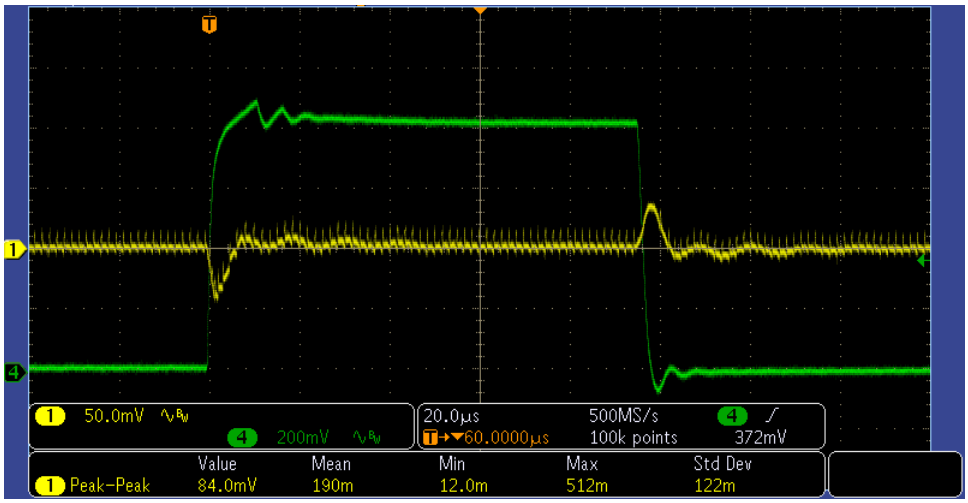

Figure 2-1. TPSM8A29 Load Transient

By contrast, notice that TPS543B20 is not stable with 2 x 100-µF (Figure 2-2), and the superfluous switching during the unload step resulted in the zero-to-peak transient of 60 mV. This output is 20 mV higher than TPSM8A29 at the same position.

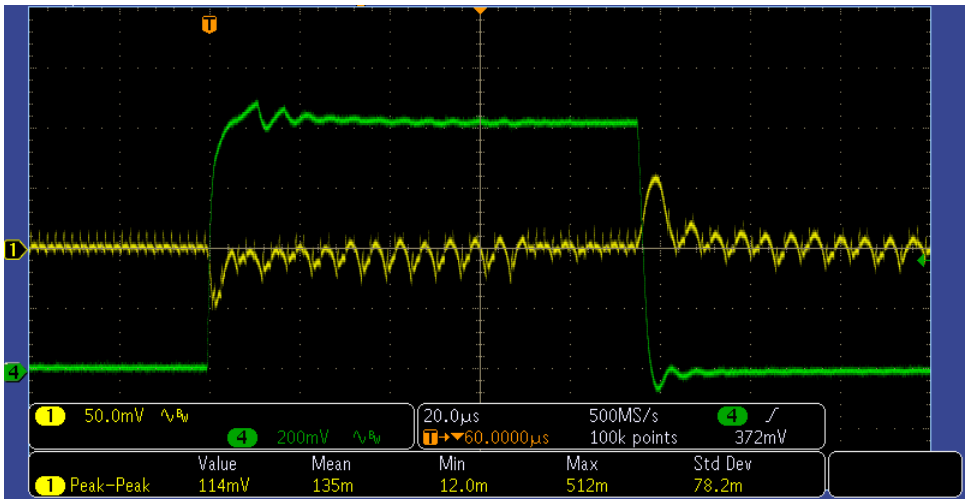

Figure 2-2. TPS543B20 Load Transient with 2 x 100-µF

When the design was iterated to improve and the transient performance, increasing output capacitance to 3 x 100-µF finally allowed the TPS543B20 to achieve loop stability, but the load transient performance of -53 mV and +45 mV (Figure 2-3), with a total of 98 mV peak-to-peak was still greater than the TPSM8A29 with 2 x 100-µF.

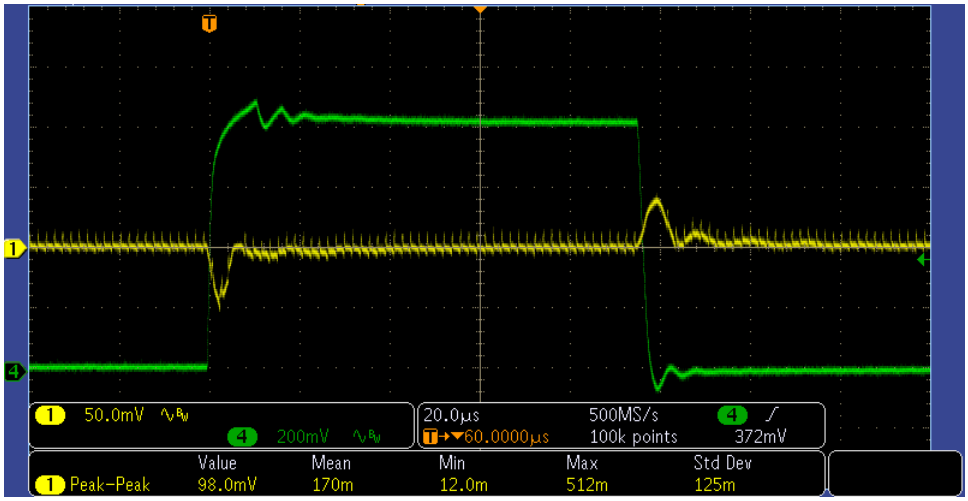

Figure 2-3. TPS543B20 Load Transient with 3 x 100-µF

3 Conclusion

Per the results of the demonstration, the D-CAP3 control topology featured in TPSM8A29 enables the device to achieve loop stability with fewer output caps, reducing overall solution size in comparison to a similarly rated fixed frequency solution while maximizing load transient performance.

Table 3-1. Final Results

	TPSM8A29	TPS543B20
Output Capacitance	2 x 100-µF	3 x 100-µF
Load Step-up	43 mV	53 mV
Load Step-down	41 mV	45 mV
Total pk-pk Voltage	84 mV	98 mV

4 Additional Resources

- Texas Instruments, *How to meet DC voltage accuracy and AC load transient specification?* TI training video.
- Texas Instruments, *Accuracy-Enhanced Ramp-Generation Design for D-CAP3 Modulation* application report.
- Texas Instruments, *Internally Compensated Advanced Current Mode*, white paper.
- Texas Instruments, *Control Mode Quick Reference Guide, Step-Down Non-Isolated DC/DC*.
- Texas Instruments, *TI Rack Server*.

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