Application Report
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Device Behavior Under Slow VBAT Ramp-Down and Ramp-Up

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ABSTRACT

This application report explains device behavior under slow battery-supply voltage ramp-up and ramp-down conditions, based on device supply-rail configuration. Laboratory test results and device simulations results are included to support the analysis and device behavior.

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1 Undervoltage Transients

Undervoltage transients can be observed on regulated supply outputs when one of the following occurs:

- The power-supply input (VBAT) of the device ramps down at a slow rate and reaches a voltage level of 6.3 V.
- The power-supply input (VBAT) of the device ramps up at a slow rate and reaches a voltage level of 6.6 V.

These transient impact the following regulated supplies:

- VDD5
- VDD3/5 when configured at 5 V
- VSOUT when configured as 5 V or higher

The VDD3/5 undervoltage transient causes a system-reset event (the NRES output is driven low) and disables the EN_DRV output.

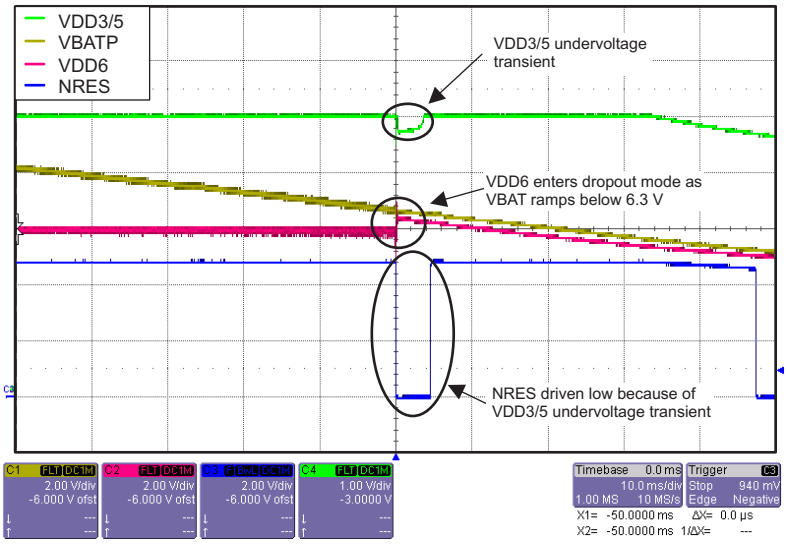

Figure 1. Battery Slow Ramp-Down Bench Measurement Result

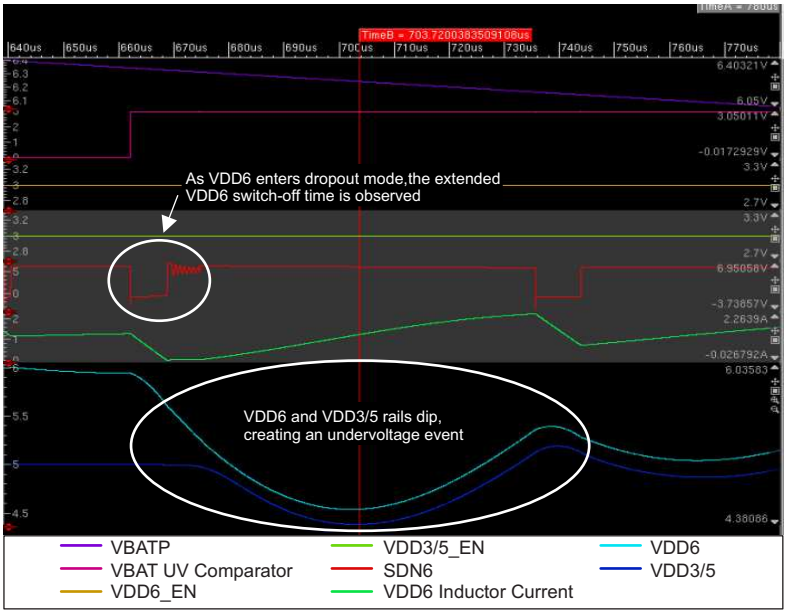

Figure 2. Battery Slow Ramp-Down Simulation Result

The VDD6 capacitor is discharged because of the extended VDD6 switch node off-time which causes a strong decrease of inductor current. Small difference between the VDD6 and VBAT terminals result in a slow increase of inductor current when the VDD6 switch node turns on.

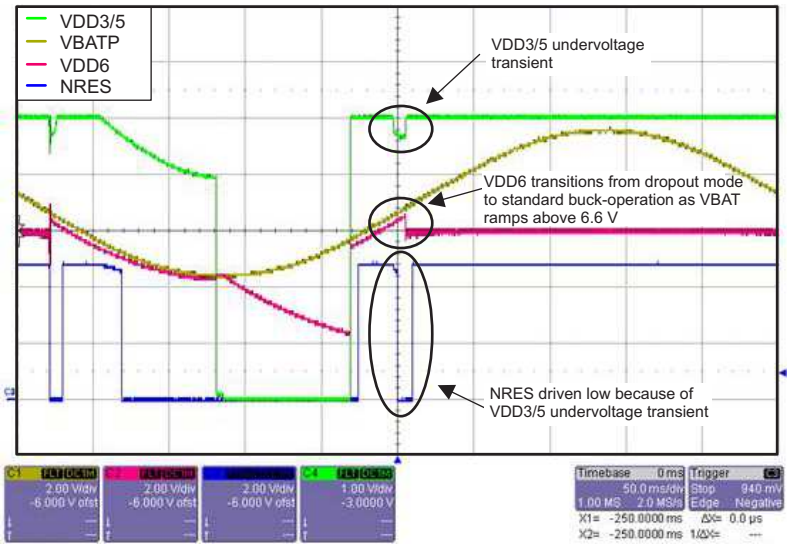

Figure 3. Battery Slow Ramp-Up Bench Measurement Result

The VDD6 terminal transitions from dropout mode to standard buck operation as the VBAT terminal ramps-up and reaches 6.6 V. In the standard buck-operation mode, when the VDD6 terminal is at 6.6 V, it is above the regulation target. Therefore the high-side (HS) switch turns off until the VDD6 terminal drops to 6 V.

During the off-period, the inductor current reduces to 0 with a rate of 200 mA/µs (for a 33-µH inductor), after which the load current on the VDD6 terminal is provided through VDD6 capacitor until the VDD6 terminal drops down to 6 V.

When turning on the VDD6 HS switch with I_{ind} = 0, the current can only increase at a rate of 18mA/us (for a 33-µH inductor and slow battery ramp-up). Until I_{ind}avg reaches I_{VDD6}, I_{VDD6} remains supplied through C_{VDD6} and the voltage decreases.

The voltage drop on the VDD6 terminal (and thus on the VDD3/5 terminal when the VDD6 terminal is less than 5 V) causes the undervoltage event on the VDD3/5 terminal which leads to NRES being driven low.

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