Low Saturation Current Inductor PVT Validation Report

Apollo3 B0

Issues with low saturation current inductor

- With the 115mA low saturation current inductor, the deep-sleep current for Apollo3 was observed to be 200µA or more in the customer's application and was reproduced by Ambiq.
- Typical deepsleep current spec is 2.4µA
- The reason for the high deep sleep current was found to be caused by inductor saturation, thereby failing to deliver sufficient charge to the simobuck VDDC and VDDF output capacitors
- In addition to the higher power, this resulted in a deregulation of the VDDC and VDDF supply rails and put the chip into a faulty state (i.e. chip may not function in deep sleep)
- To fix this issue, the time for which the simobuck is in the charging phase was reduced (Ton/Toff trim setting changes), thereby also reducing the peak current flow through the inductor

TON/TOFF trim setting changes

- These are the recommended trim settings for low saturation current inductors below ~400mA over a limited VDDH range of 1.755 to 1.9 V and operating temperature range from -20°C to 60°C
- simobuck_core_lp_low_ton_trim_init_value = 3
- simobuck_core_lp_high_ton_trim_init_value = 2
- simobuck_core_lp_low_toff_trim_init_value = 2
- simobuck_core_lp_high_toff_trim_init_value = 5
- simobuck_mem_lp_low_ton_trim_init_value = 3
- simobuck_mem_lp_high_ton_trim_init_value = 3
- simobuck_mem_lp_low_toff_trim_init_value = 1
- simobuck_mem_lp_high_toff_trim_init_value = 6
- simobuck_zx_trim_init_value = 0xA

Power Comparison

- Power measurement comparisons were conducted between low saturation current (115 mA) inductor with the recommended trims (on previous slide) and high saturation current (2 A) inductor with the default trims

Process	VDDH	Test	Low Sat. Inductor Power (new trims)	High Sat. Inductor Power (old trims)
Slow	1.755 V	Coremark	1168 µA	1215 µA
Slow	1.755 V	Deeplseep	1.3 µA	2.3 µA
Fast	1.755 V	Coremark	1016 µA	1026 µA
Fast	1.755 V	Deeplseep	1.5 µA	1.8 µA
Typical	1.755 V	Coremark	1059 µA	1041 µA
Typical	1.755 V	Deeplseep	1.4 µA	2.2 µA

Validation Effort

- **Test Conditions:** Low saturation current simobuck inductor installed on the Apollo3 B0 validation system boards with a VDDH voltage operating range of 1.755 to 1.9 V and temperature range of -20°C to 60°C with the new trim settings
- **Results:** All Ambiq load regulation and functional regression stress testing **PASSED**