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A Single-Inductor Dual-Output DC-DC Converter with Dual-Mode Control

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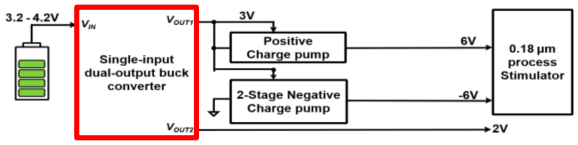
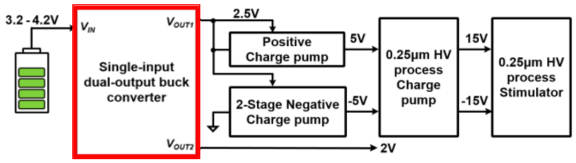
Introduction

- Through stimulation to treat neurological disorders such as Parkinson's disease and epilepsy.
  - Need to provide a pair of positive and negative stimulus pulses.
    - SIDO buck converter provides two regulated outputs for stimulator and digital circuits.
  - Use pulse-skip modulation to control the buck converter to provide V_{OUT1}=3V and V_{OUT2}=2V.
  - Use pulse-width modulation to control the buck converter to provide V_{OUT1}=2.5V and V_{OUT2}=2V.

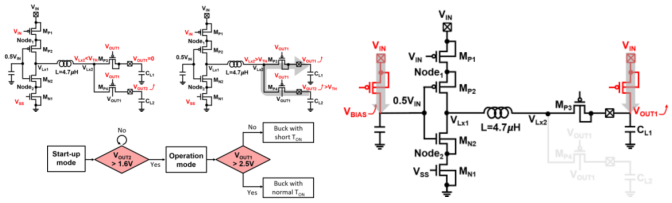


This work (a) Pulse-skip modulation



(b) Pulse-width modulation Figure from reference

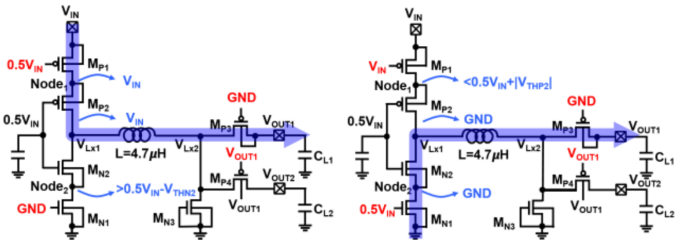
Characteristics



pulse-skip modulation pulse-width modulation

Figure from reference

- The OTG and ZCD produce appropriate signals for power stage to achieve high conversion efficiency under wide input voltage range.
- The pulse-width modulation includes one ramp generator and one type-III compensator to achieve faster convergence speed and lower phase noise under wide input voltage range.

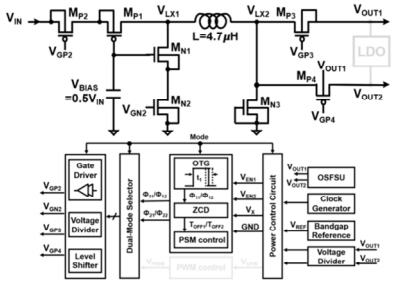


(a) On-time period (b) Off-time period

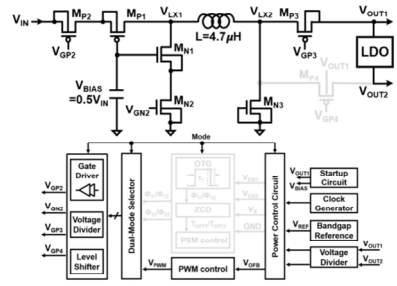
Figure from reference

- M_{P1}, M_{P2} and M_{P3}(or M_{P4}) will turn on, M_{N2} will turn off to prevent MN1 if $Node_2$ higher than $0.5V_{IN}$-V_{THN2}.
- M_{N2}, M_{N1} and M_{P3}(or M_{P4}) will turn on, M_{P2} will turn off to prevent M_{P1} if $Node_1$ higher than $0.5V_{IN}$+$|V_{THN2}|$.

System Architecture



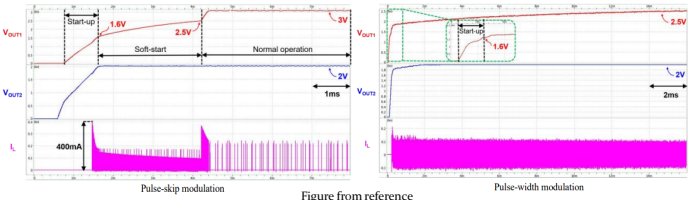
(a) Pulse-skip modulation



(b) Pulse-width modulation Figure from reference

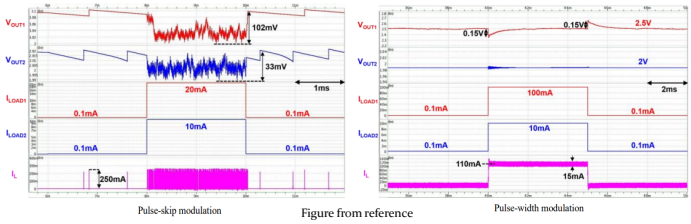
- The mode will be decided through the dual-mode selector.
- The OSFSU will directly charge the output by the path from V_{IN} to V_{OUT2}.
- The start-up circuit will directly charge the output by the path from V_{IN} to V_{OUT1}.

Simulation Results



Pulse-skip modulation Figure from reference Pulse-width modulation

- Simulated waveforms of single-inductor dual-output converter.



Pulse-skip modulation Figure from reference Pulse-width modulation

- Simulated waveform of load transient.

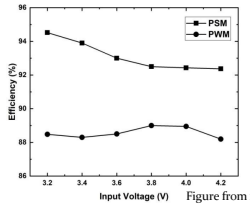


Figure from reference

- This work achieves a maximum conversion efficiency of 94.5% with pulse-skip modulation and 89.1% with pulse-width modulation.

Reference

Y. -H. Hsu, D. -H. Yao and P. -H. Chen, "A Single-Inductor Dual-Output DC-DC Converter with Dual-Mode Control," *2020 International Conference on Electrical, Communication, and Computer Engineering (ICECCE)*, 2020, pp. 1-4, doi: 10.1109/ICECCE49384.2020.9179190.

Acknowledgement

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