

P72 A Simple Feed-Forward Controller Design for DC-DC Buck Converter

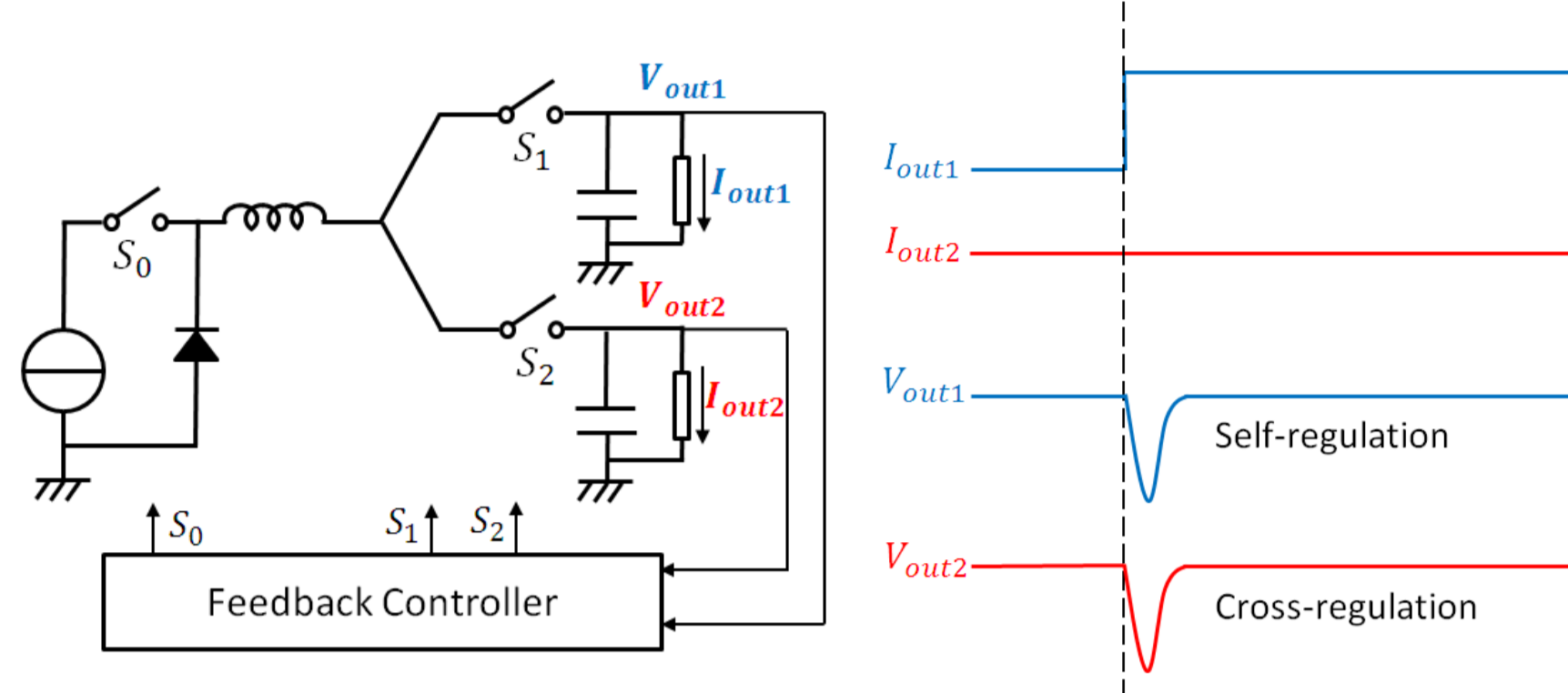
Shu Wu, Yasunori Kobori, Zachary Nosker, Murong Li, Feng Zhao, Li Quan, Qiulin Zhu, Nobukazu Takai, Haruo Kobayashi
 Dept. of Electronic Engineering, Graduate School of Engineering Gunma University, 1-5-1 Tenjin-cho, Kiryu 365-8515, Japan

t12802472@gunma-u.ac.jp k_haruo@el.gunma-u.ac.jp

Introduction

Single-Inductor-Dual-Output (SIDO) converter

- 😊 Reduction of power loss, volume, cost
- 😞 Problem: cross-regulation



Essential Problem: Transient Response

Research Objective

Proposed Feed-forward Control

Principle

- Charge balance of output capacitor

Advantage

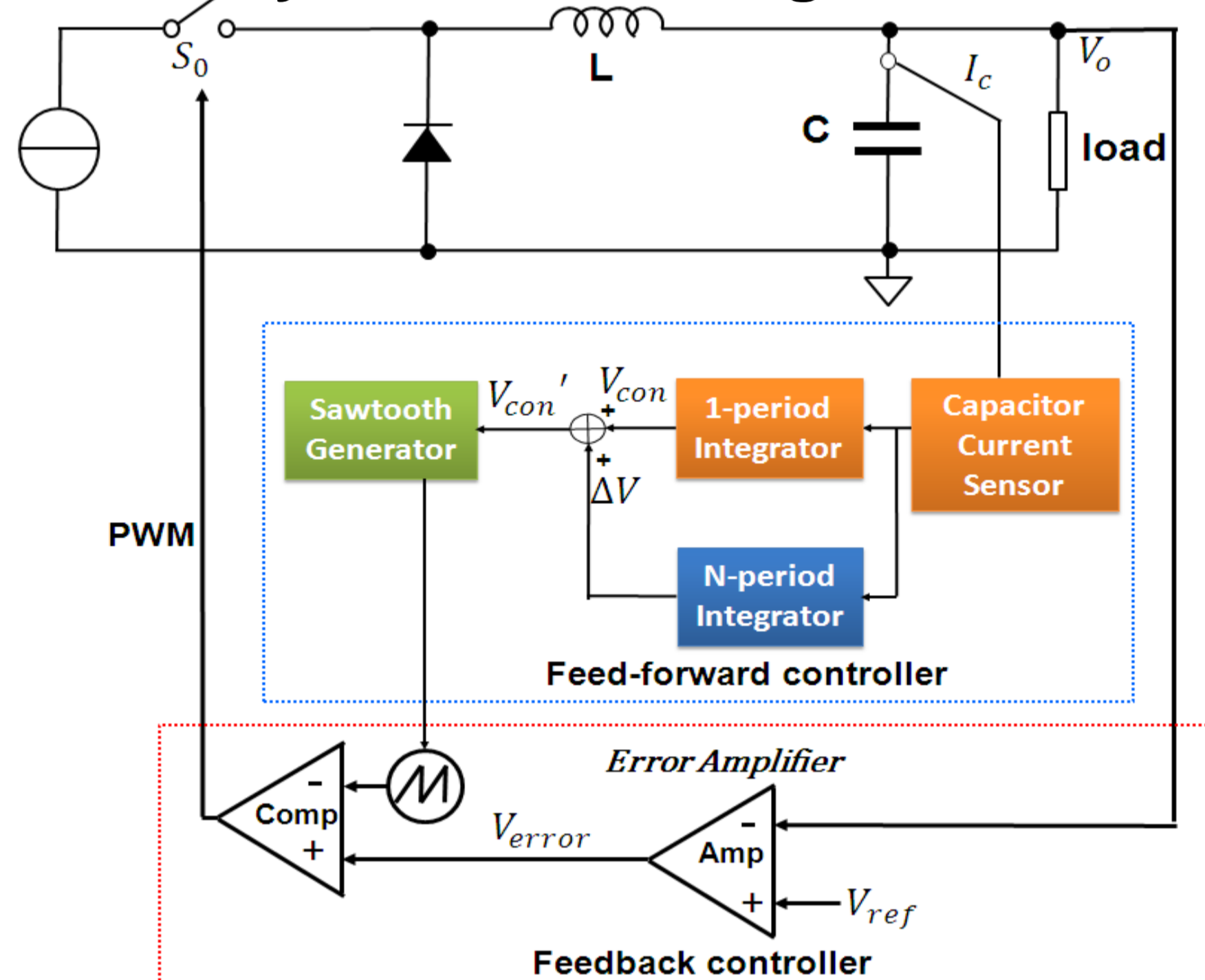
- Simple
- Fast transient response
- Cross-regulation improvement for SIDO buck converter

Conventional Method

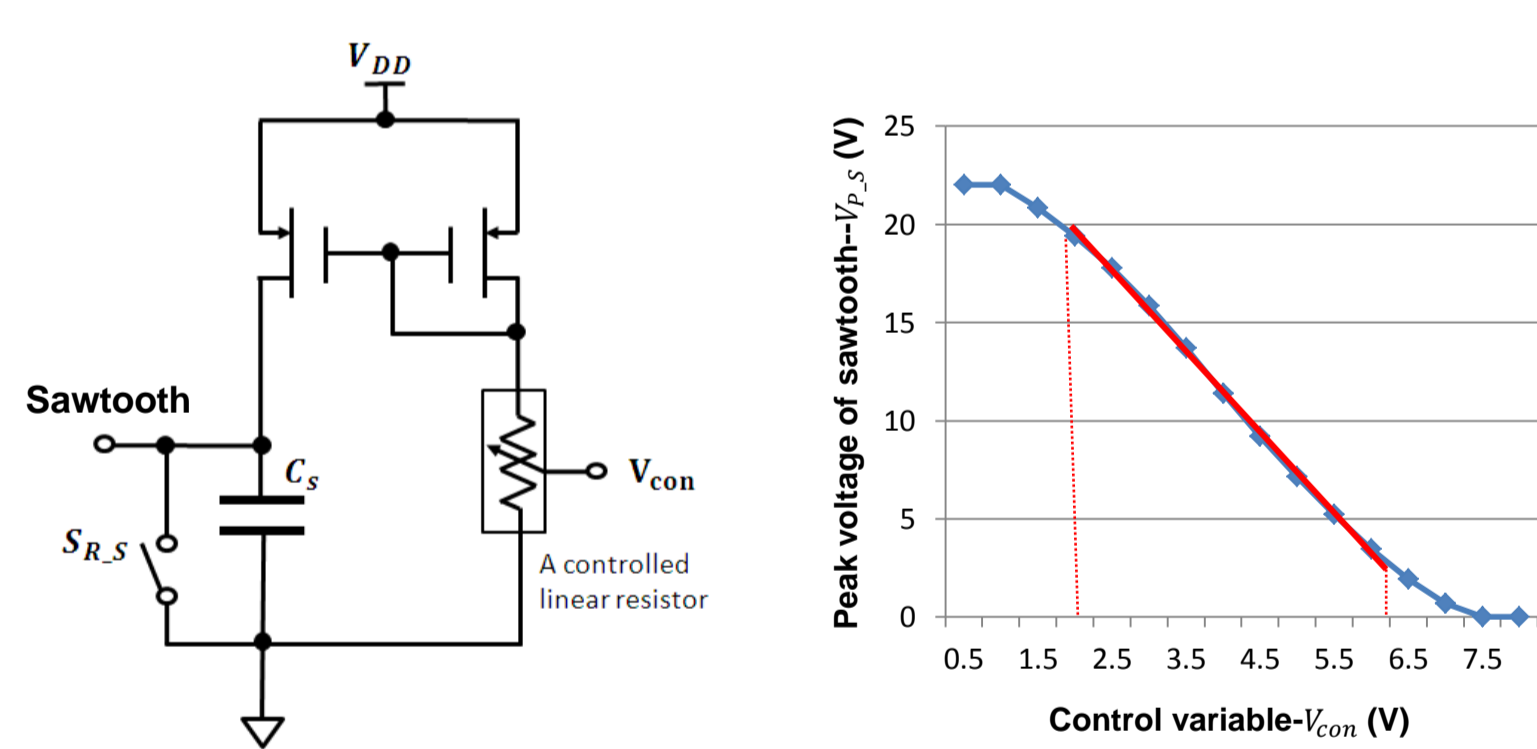
- Feed-back control
 - **Control Delay** during transient response
- **Feed-forward + Feed-back control**
 - Require accurate modulation
 - Digital non-linear feed-forward control
 - **Complicated**
 - **Not cost-effective**

Feed-forward Controller for DC-DC Buck Converter

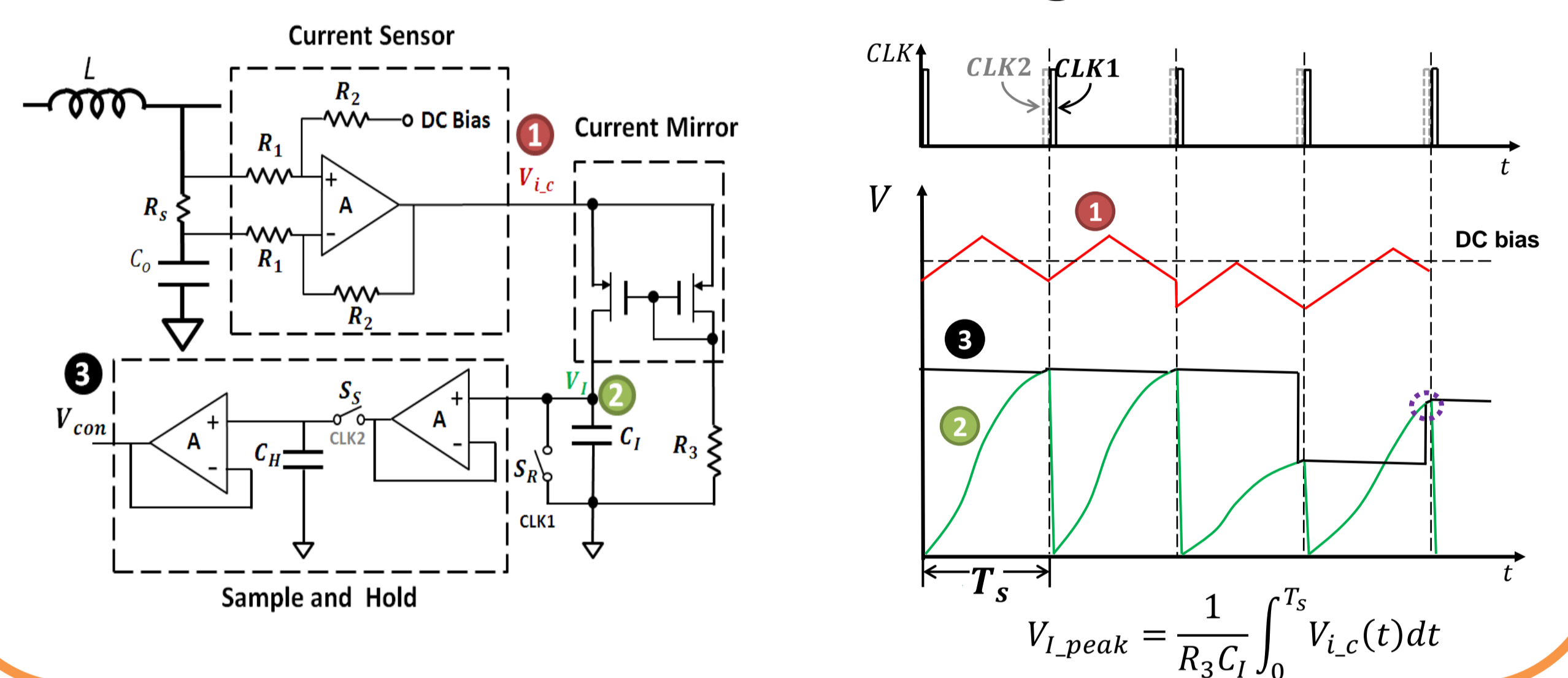
System Block Diagram



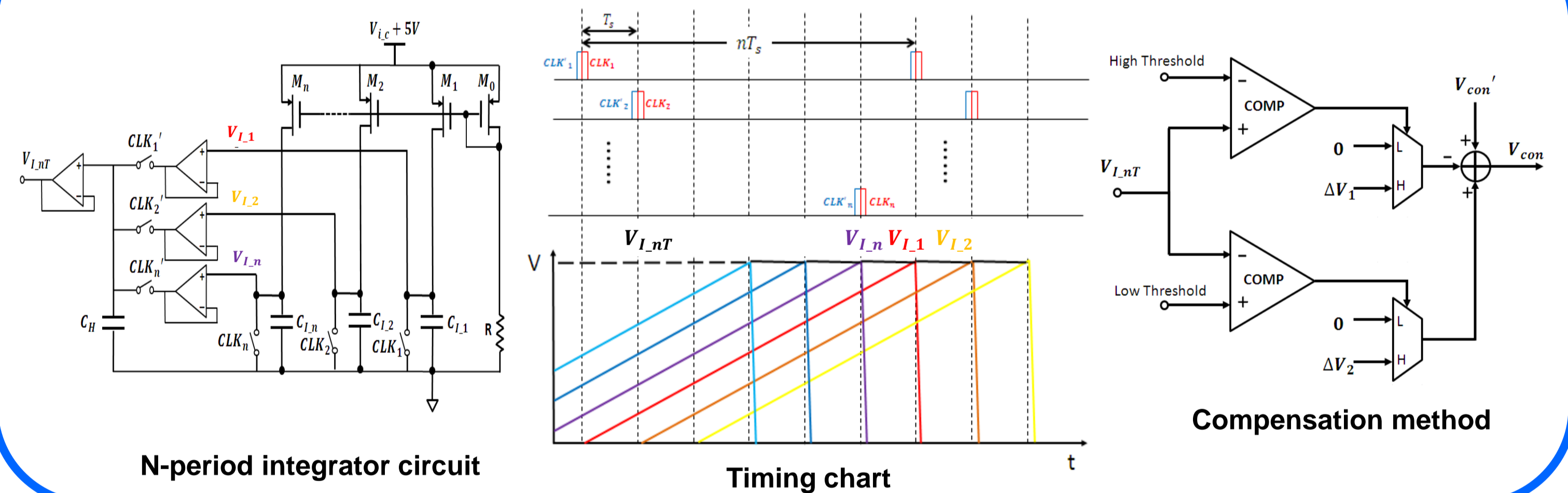
Sawtooth Generator



Current Sensor & Integrator

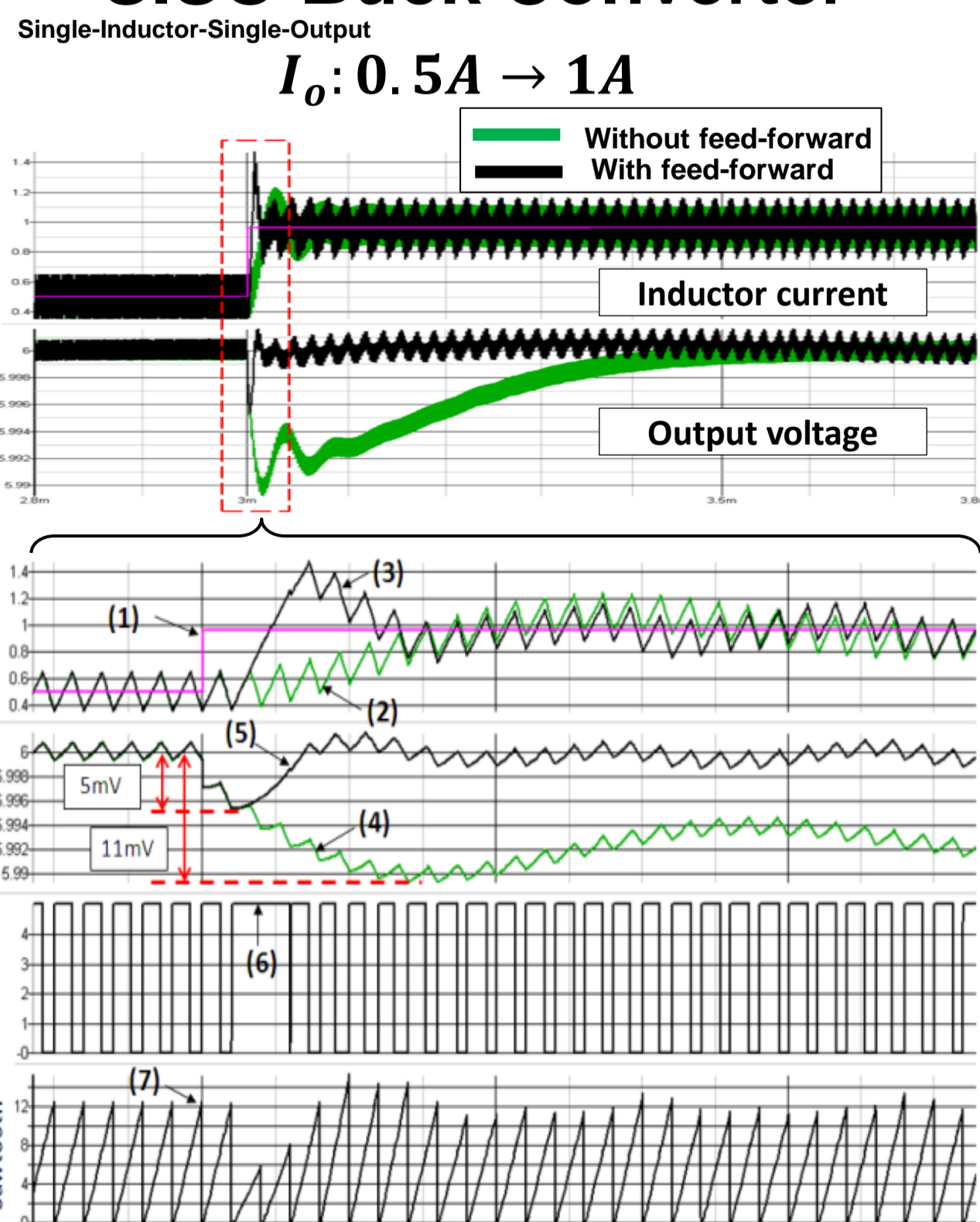


Multi-period Integration Compensation



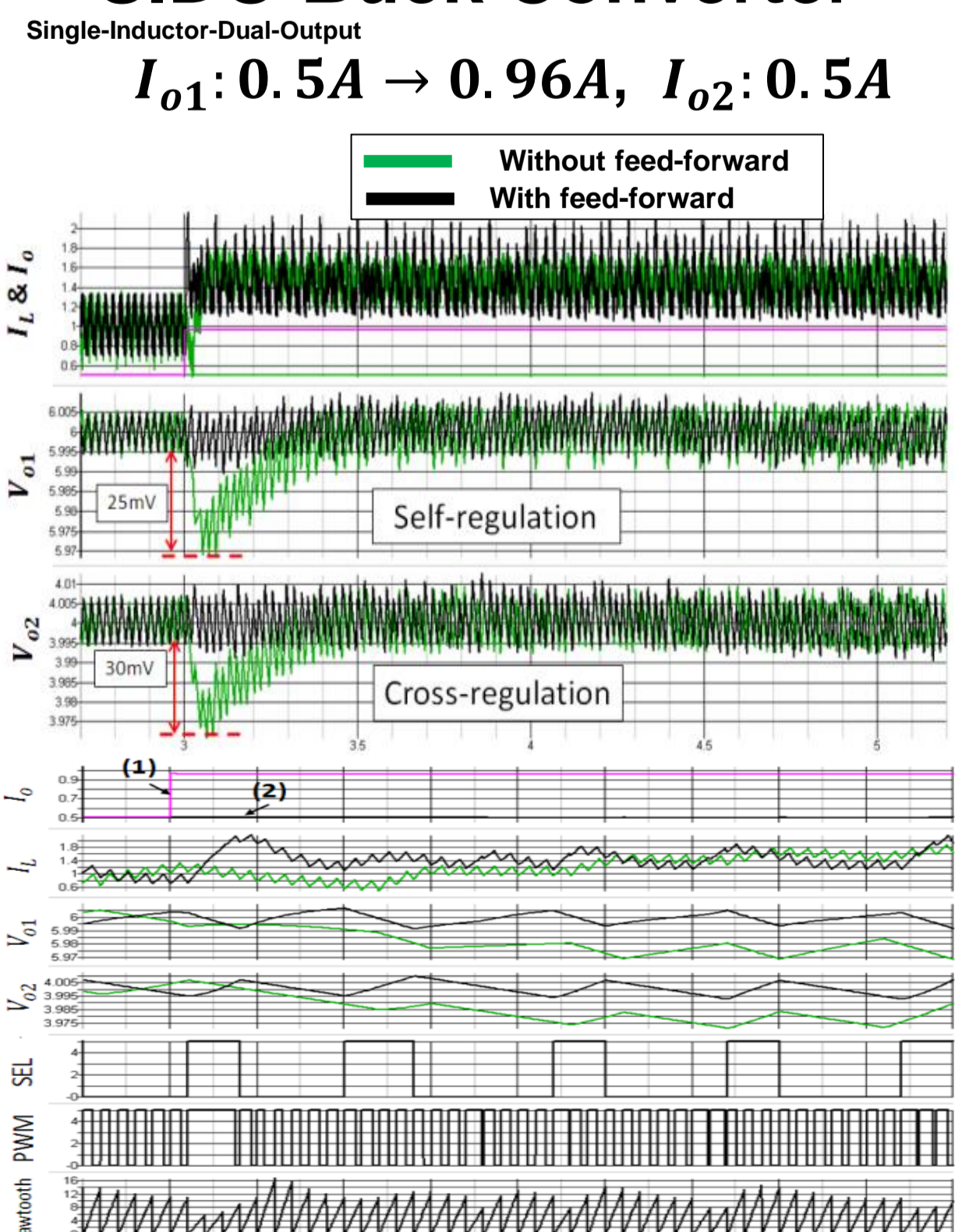
Simulation

SISO Buck Converter



	Feed-forward	With	Without
Under-shoot		5mV	11mV
Response time		8μs	500μs

SIDO Buck Converter



	Feed-forward	With	Without
Self-regulation		--	25mV
Cross-regulation		--	30mV

Summary

Simple Design:

- ◆ Only output capacitor current is detected
- ◆ Digital nonlinear calculation is NOT required
- ◆ ADC, DSP are NOT required

- Applicable to SIDO converter
- Cost-effective

Enhanced Performance:

- ◆ Transient response is significantly improved
- Cross-regulation of SIDO converter is improved

Reference

- Y. Kobori, Q. Zhu, et al., "Single Inductor Dual Output DC-DC Converter Design with Exclusive Control", IEEE Asia Pacific Conference on Circuits and Systems, pp. 436-439, Kaohsiung, Taiwan, Dec. 2012.
- S.Y. Chae, B.C. Hyun, W.S. Kim, B.H. Cho, "Digital load current feed-forward control method for a DC-DC converter", Applied Power Electronics Conference and Exposition, pp. 498-502, Austin, TX, USA, Feb 2008.
- A. V. Peterchev, S. R. Sanders, Load-line regulation with estimated load-current feed-forward application to microprocessor voltage regulators, IEEE Trans. Power Electronics, vol. 21, no.6, pp. 1704-1717, Nov. 2006.