

マルチフェーズ COT リプル制御電源における 自動電流バランス補正

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1. Objective

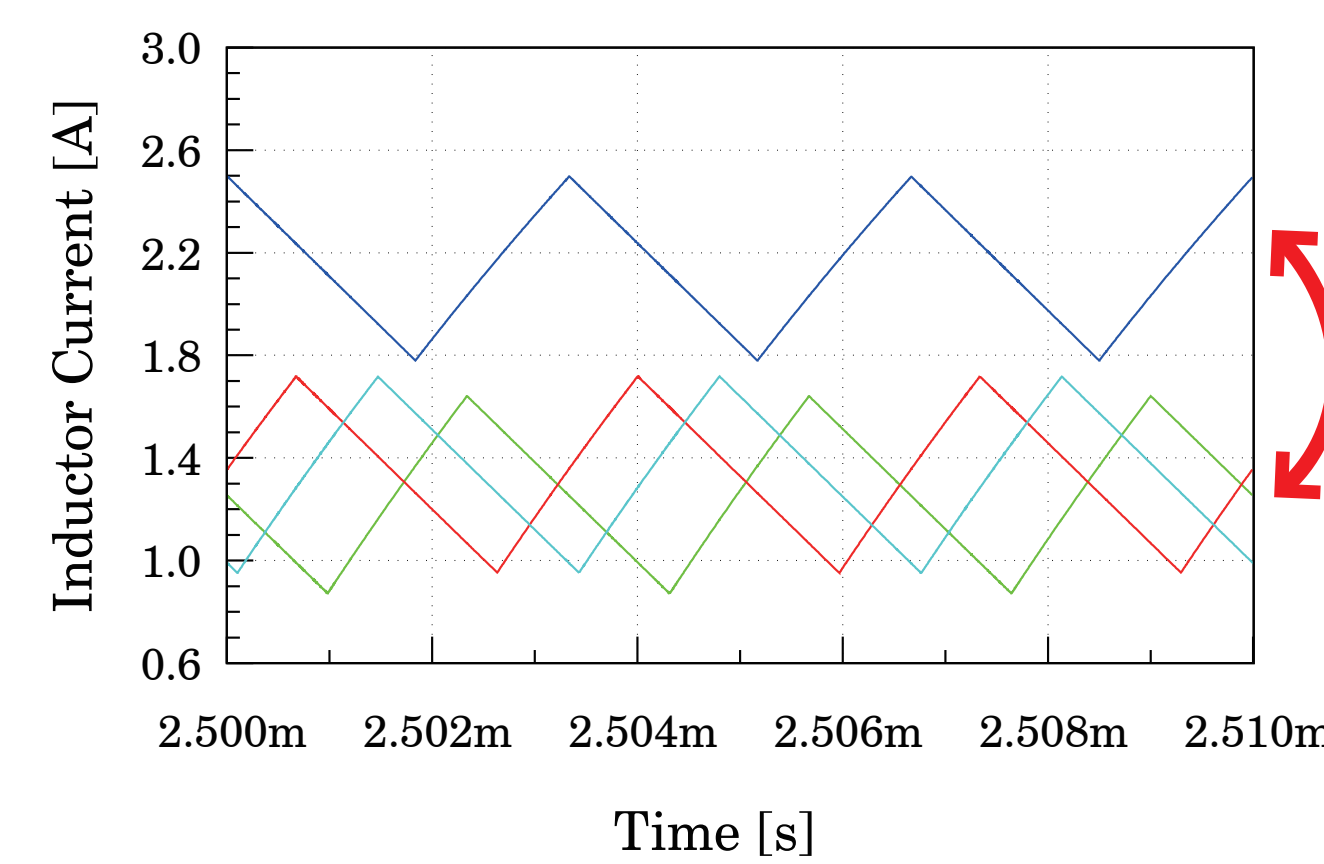
COT ripple-based control DC-DC converter

- For large load current
Multi-Phase configuration
- Automatic current imbalance correction
Feedback the current difference

COT: **C**onstant **O**n-Time

2. Background

Current imbalance from L, C element variation



Causes overcurrent
Increase voltage ripple
Current imbalance



Goal

Automatic current balancing

3. Proposed Circuit

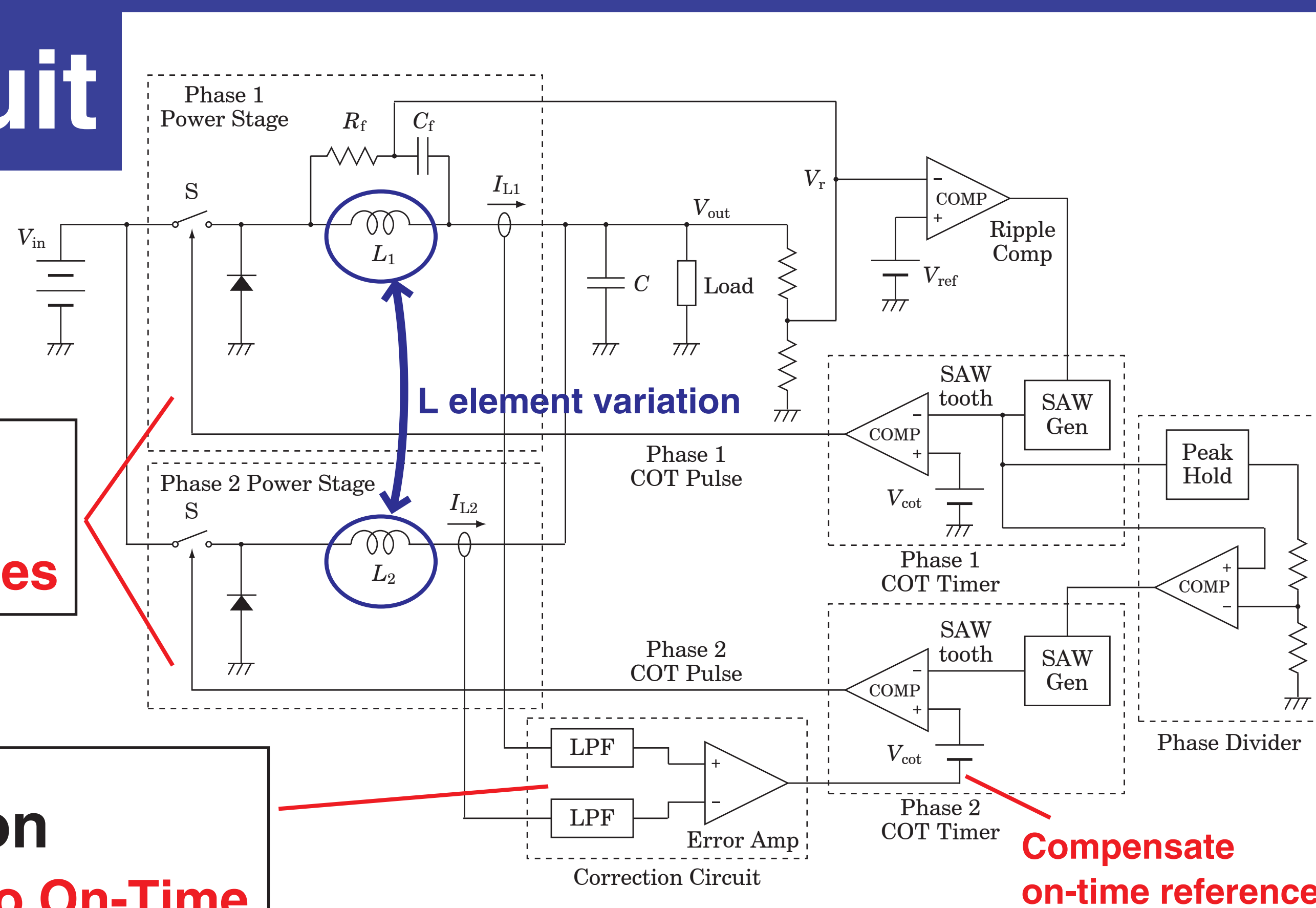
Dual Phase COT Converter

Proposal 1

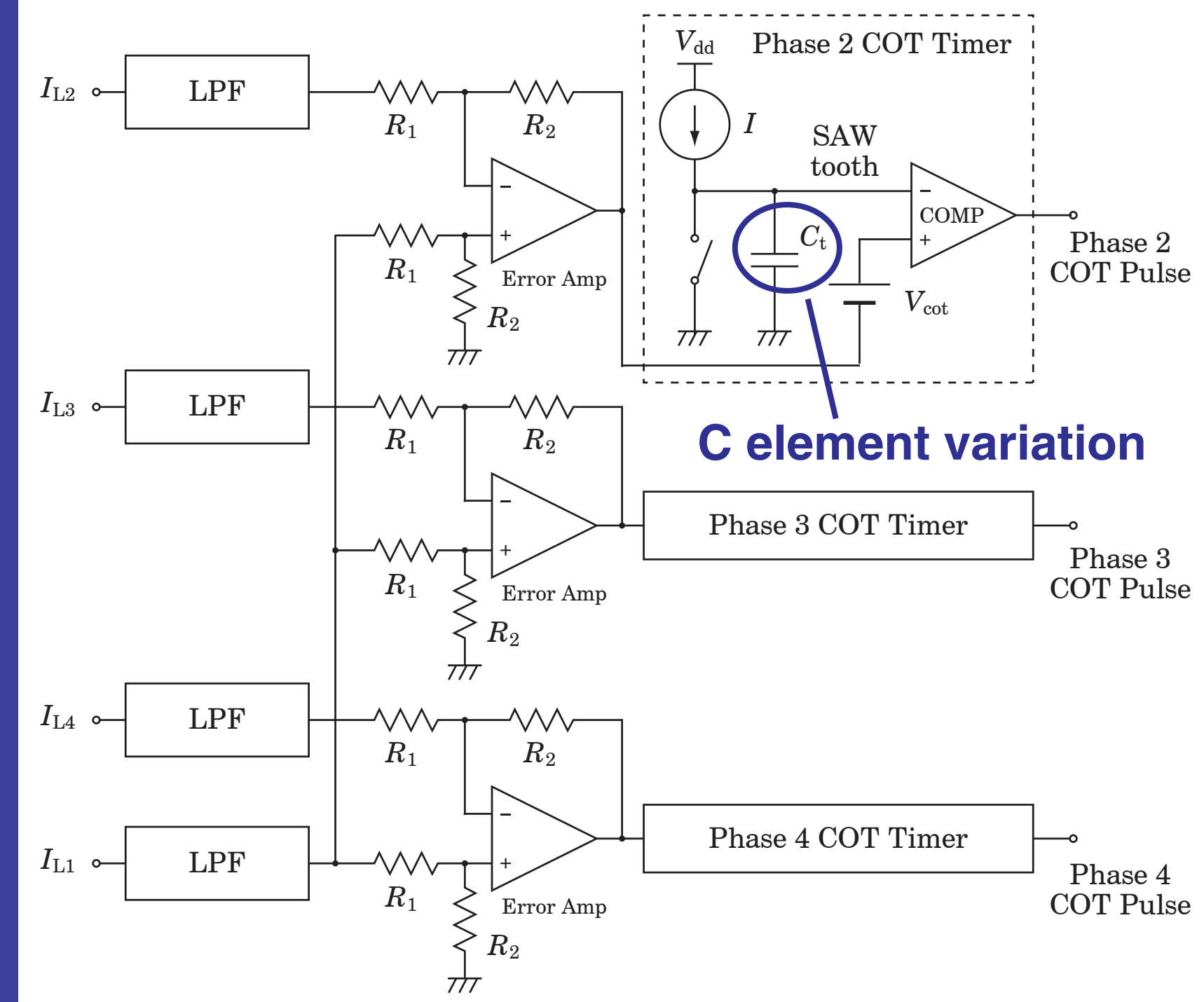
For large load current
Parallel connection of power stages

Proposal 2

Current imbalance correction
Feedback the current difference to On-Time



In Quad-Phase



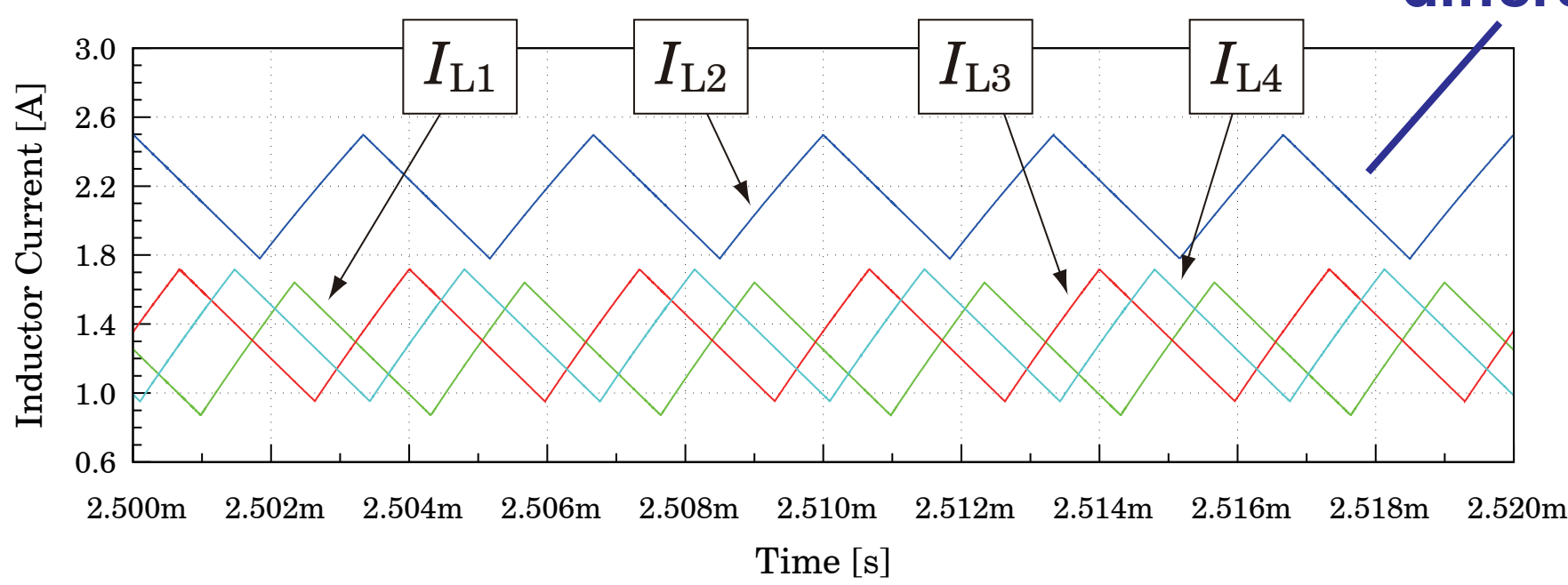
Feedback the current difference to each sub-converter

4. Simulation

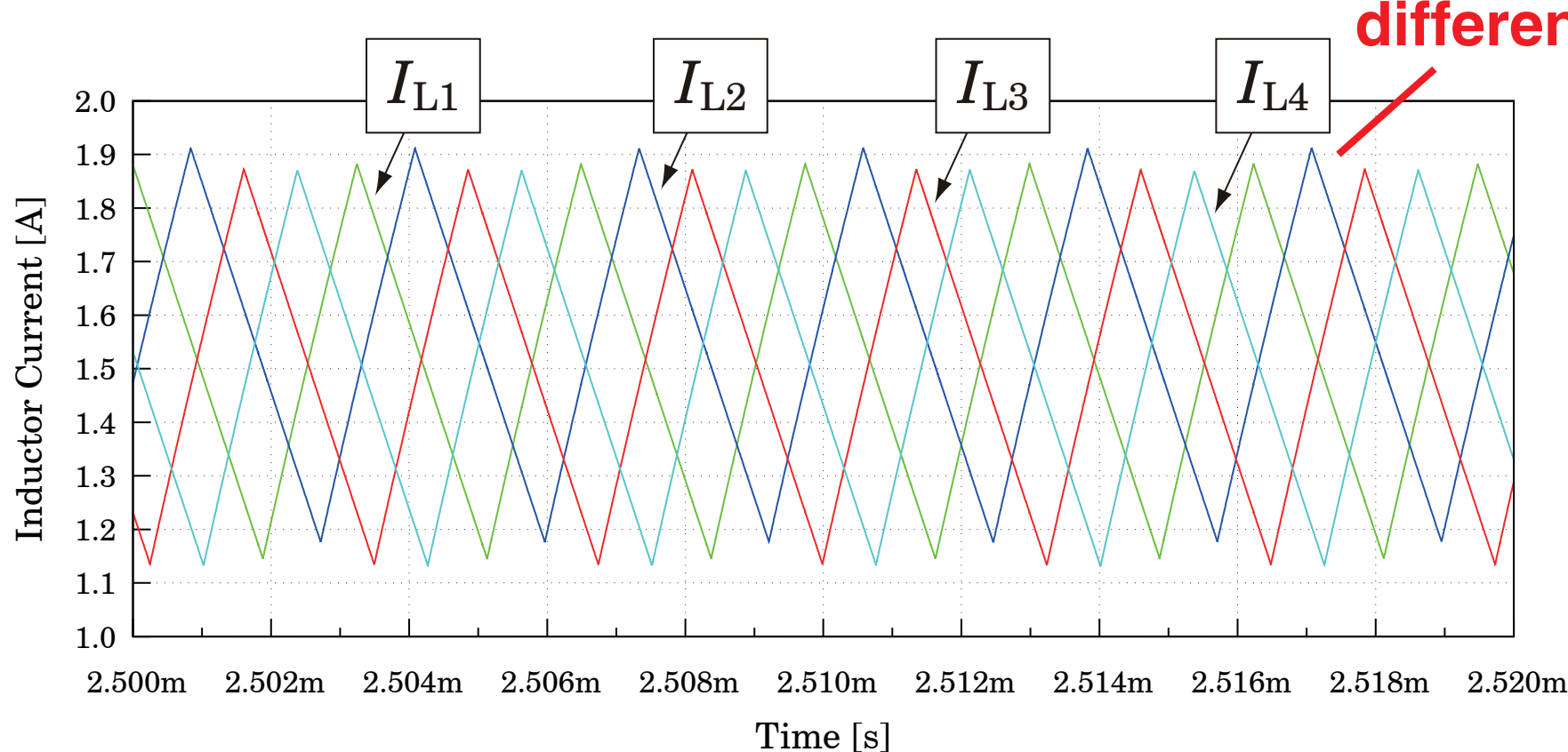
Conditions

Element variation: C_{t2} increase by 10%

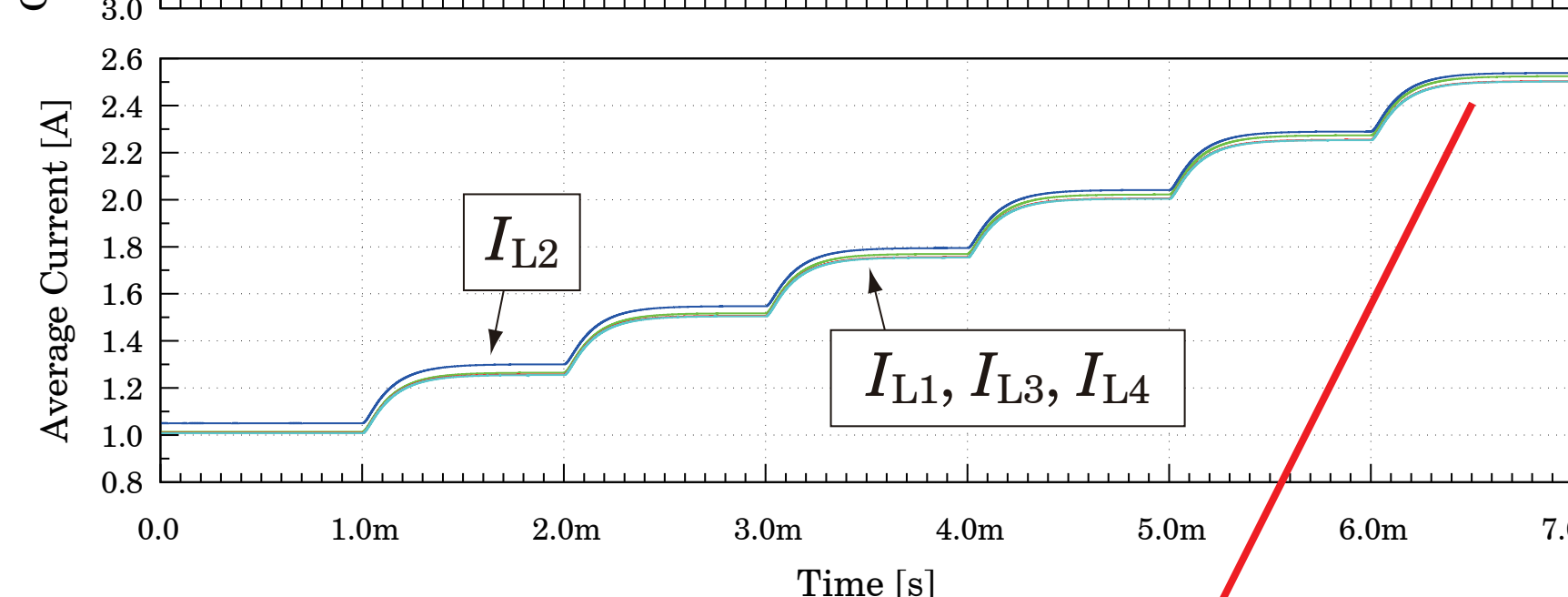
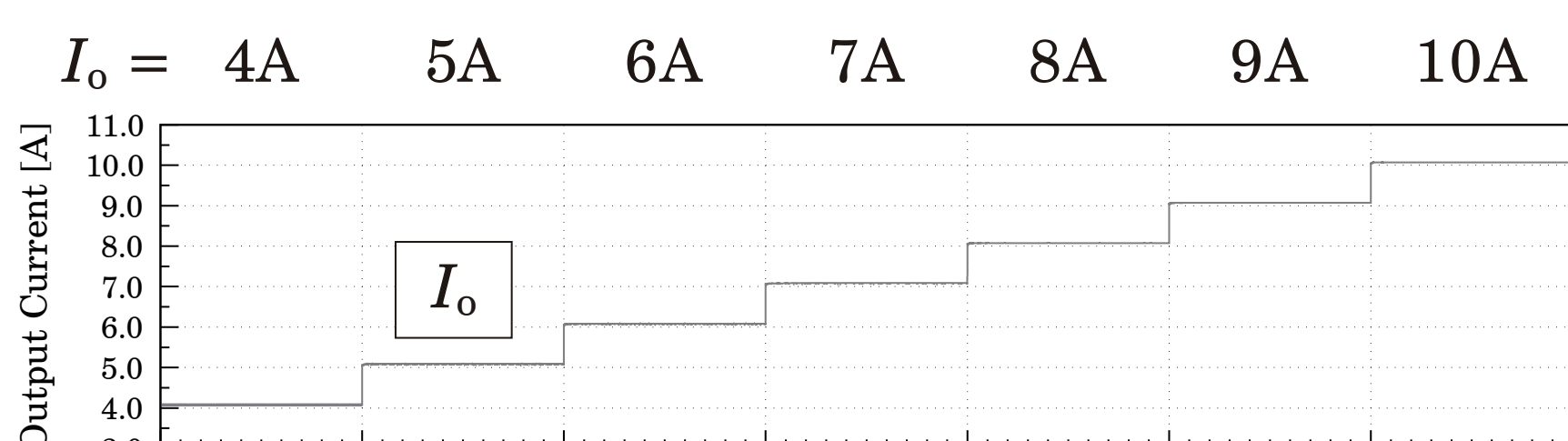
Before imbalance correction Inductor current difference 41%



After imbalance correction Inductor current difference 1%



Increase load current 4A to 10A



$I_o = 10A$: Inductor current difference 2%

Proposal correction circuit in large load current: **Stable**

5. Conclusion

COT ripple-based control converter for large load current

- Automatic current imbalance correction
 - Correcting the on-time of the COT pulse by the error amplifier feedback control
 - Error amplifier feedback the inductor current difference to on-time reference
 - Simulate proposal correction circuit
 - Increase 10% COT timer capacitor C_{t2}
 - Without correction circuit: Inductor current difference 41%
 - Within correction circuit: Inductor current difference 1%
- Current balance improves significantly**

References

- H. Kobayashi, T. Nabeshima (Editors), Handbook of Power Management Circuits, Pan Stanford Publisher (2016)
- Y. Xiong, K. Asaishi, N. Miki, N. Tsukiji, Y. Kobori, H. Kobayashi, "Constant On-Time Controlled Four-Phase Buck Converter via Two Ways of Saw-tooth-wave Circuit and PLL Circuit", IEEE International Symposium on Intelligent Signal Processing and Communication Systems, Xiamen, China (2017).
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