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Single Inductor Dual Output DC-DC converter Design with Exclusive Control

7021

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Outline

- Research Objective
- SIDO Converter with Two Buck Converters
  - Proposed Circuit and Operation
  - Simulation Results
- SIDO Converter with Two Boost Converters
  - Proposed Circuit and Operation
  - Simulation Results
- Conclusion

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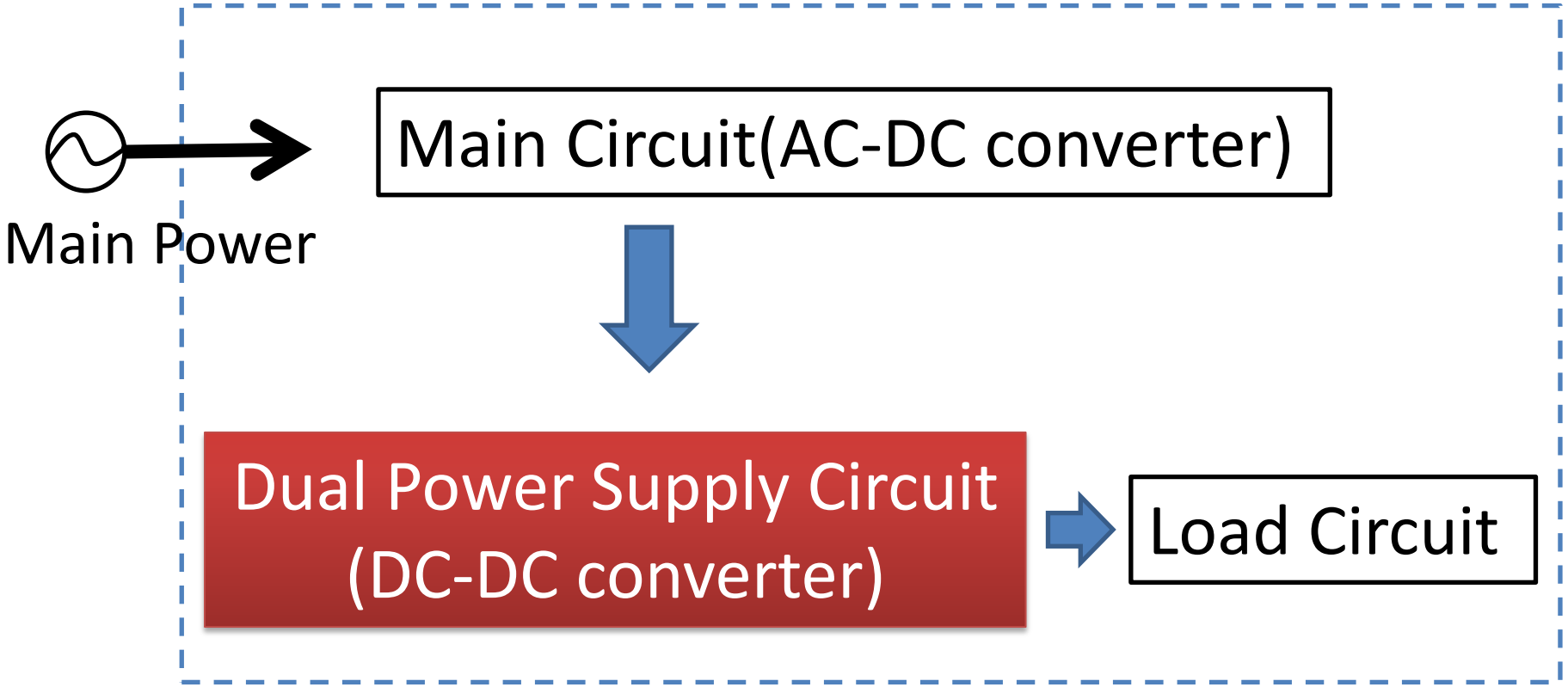
Background

Cell phones, manufacturing machinery, etc.



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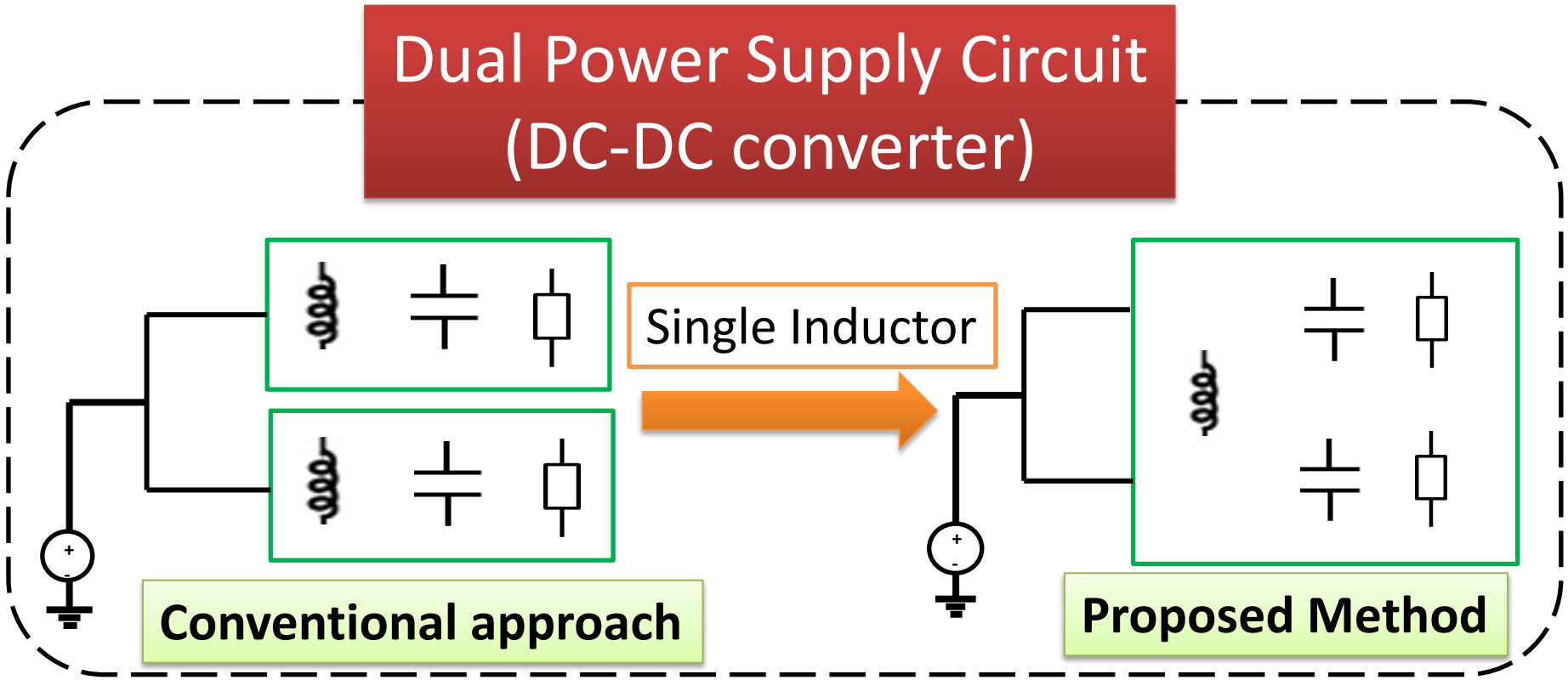

Reduce inductor

Reduce cost
Reduce volume

Research Objective

- Single inductor dual output DC-DC converter
  - Development of

    single, low cost control method
- Exclusive control

Our approach

Research Objective

Our approach

- Conventional both ch1 or ch2 control in one period

- Proposal of exclusive control
  - Either ch1 or ch2 control in one period
  - Only a few additional components
  - No current sensor

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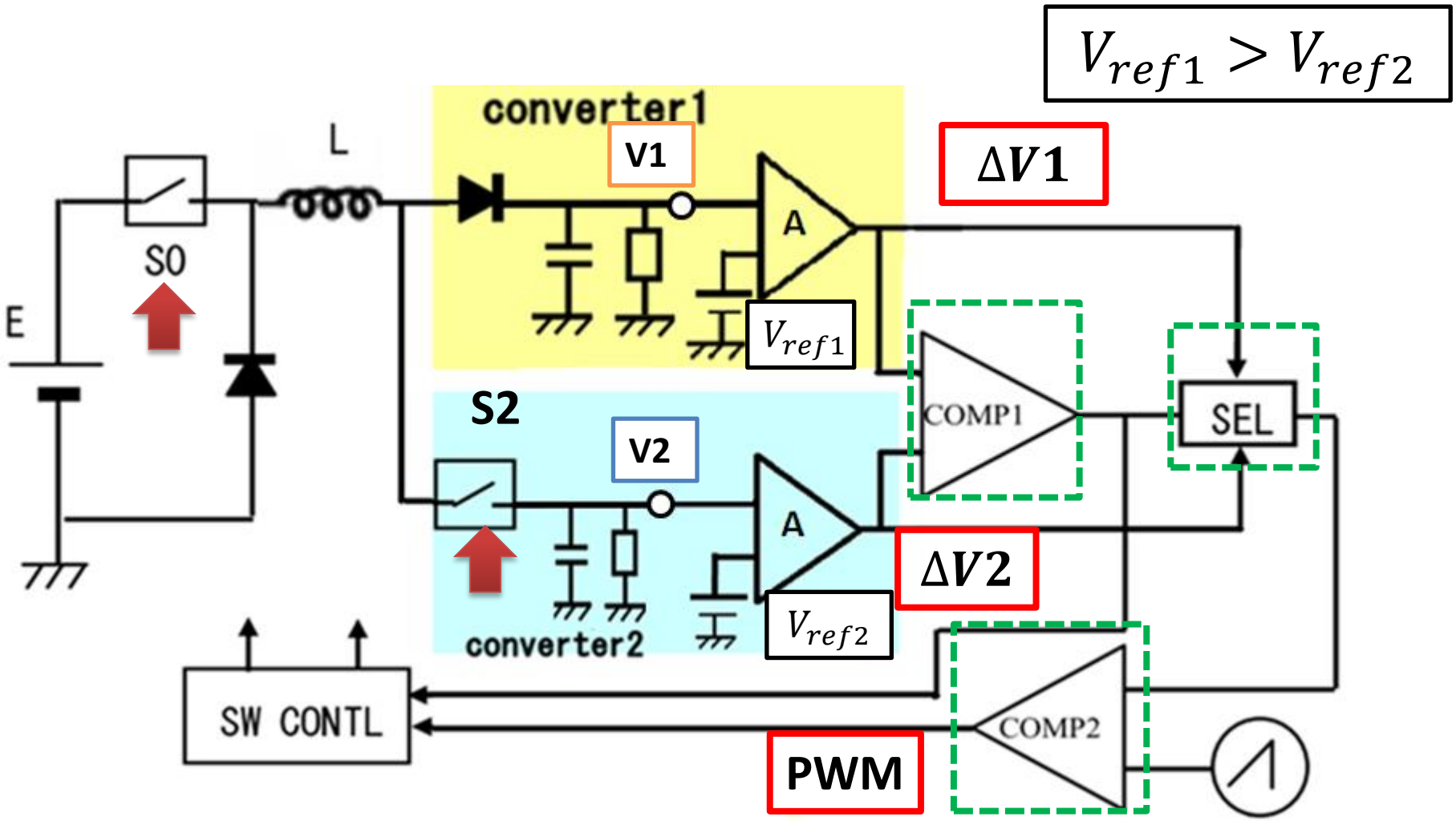
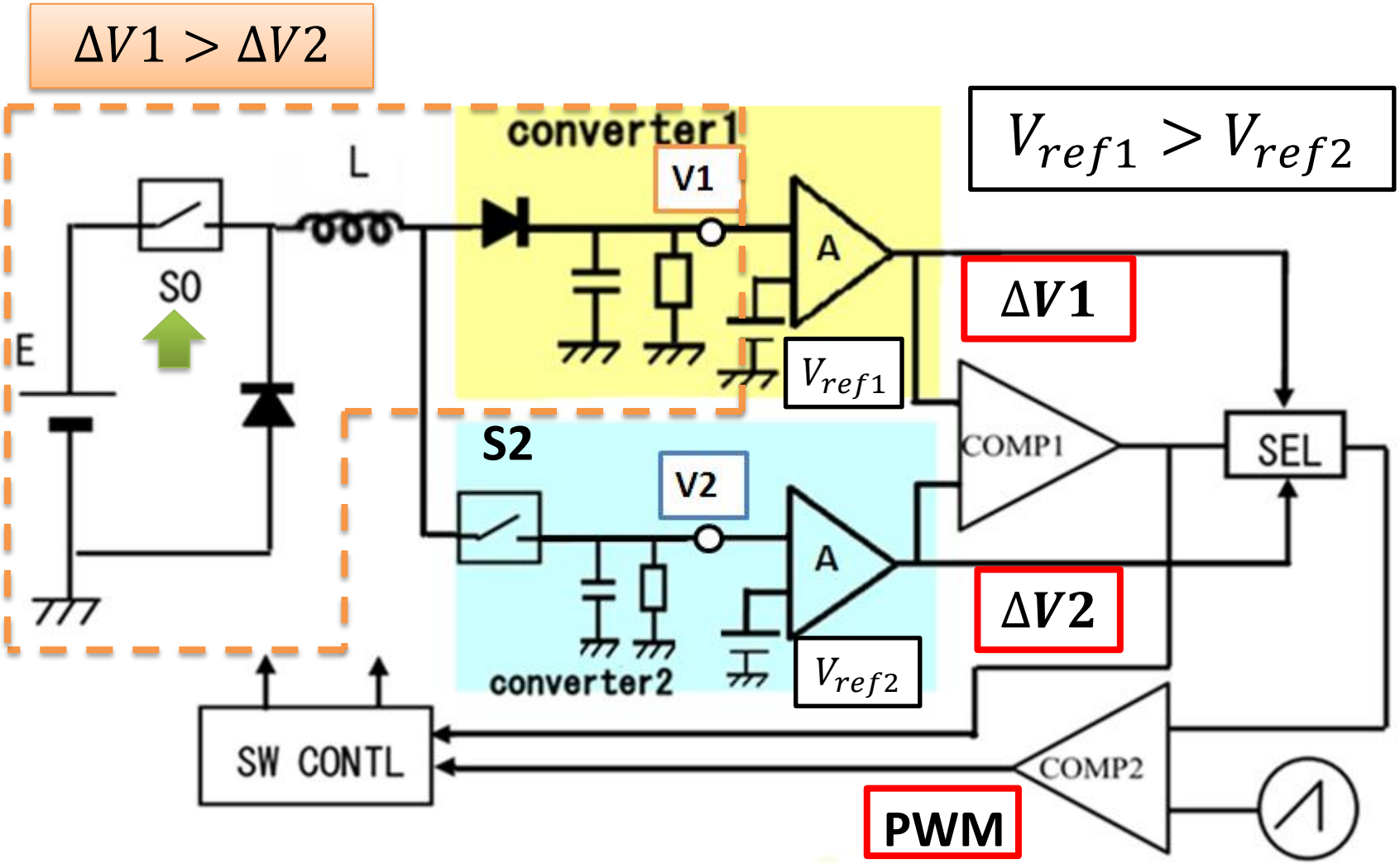
Proposed Control of SIDO with Two Buck Converters

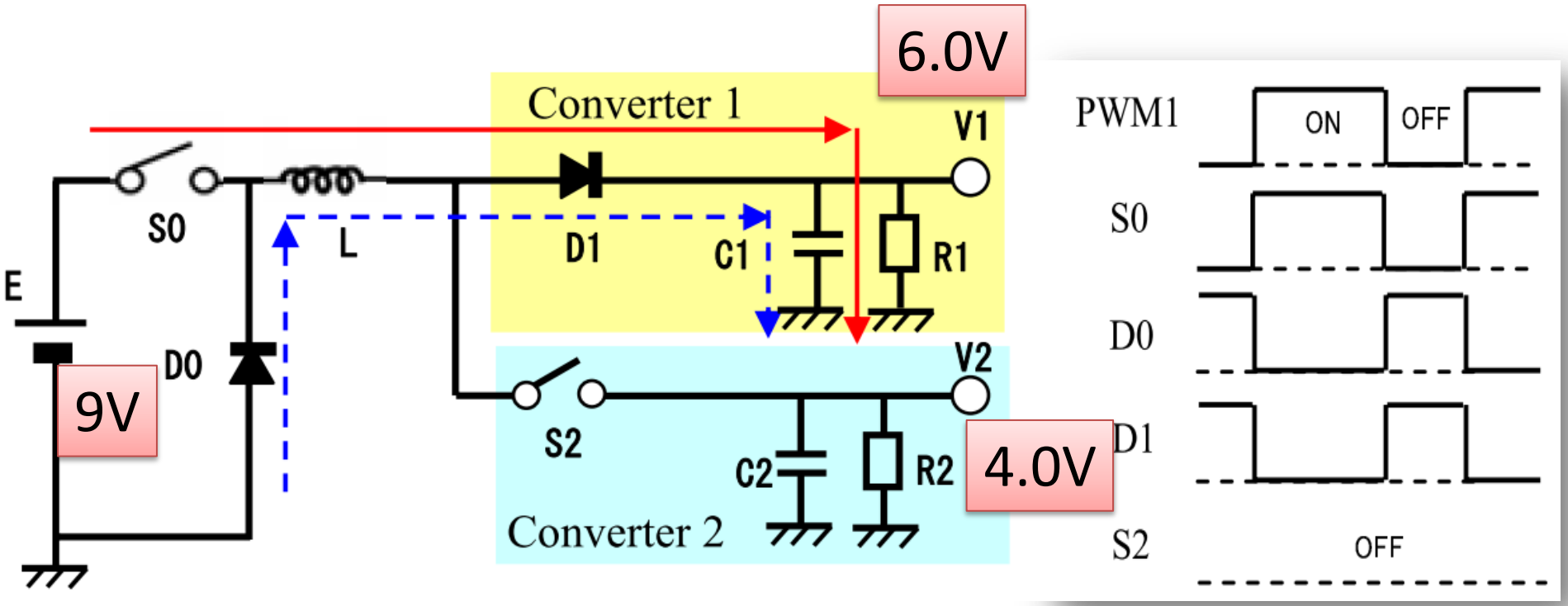


Proposed Control of SIDO with Two Buck Converters

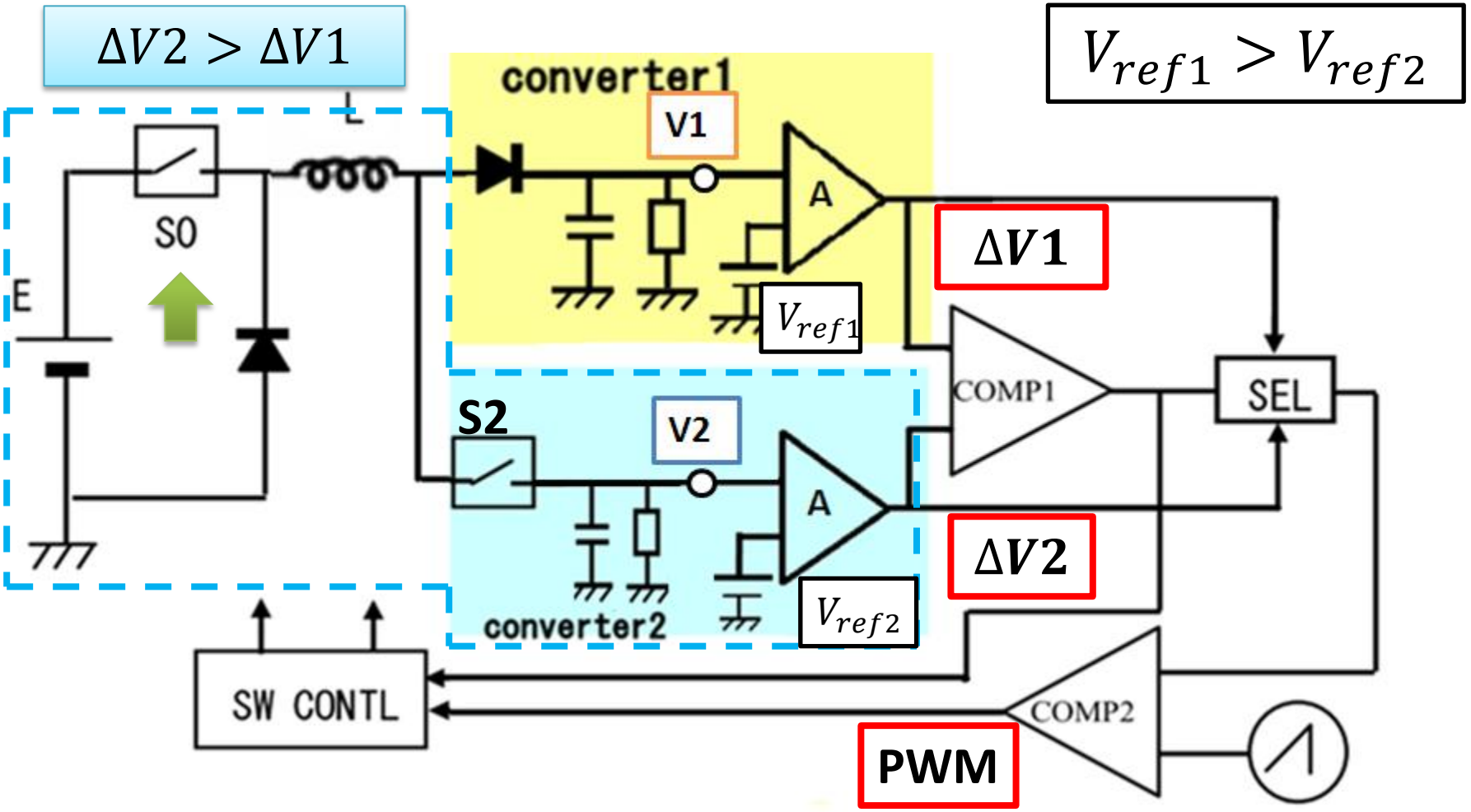


Buck-Buck SIDO Converter

Converter 1 control

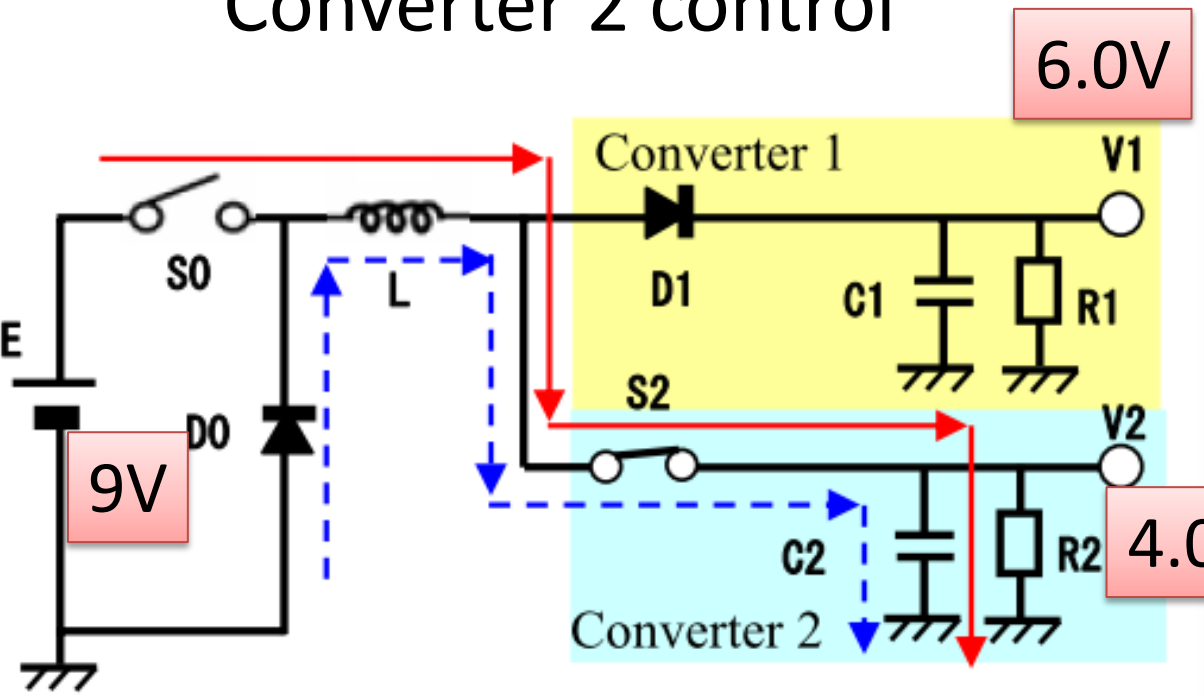


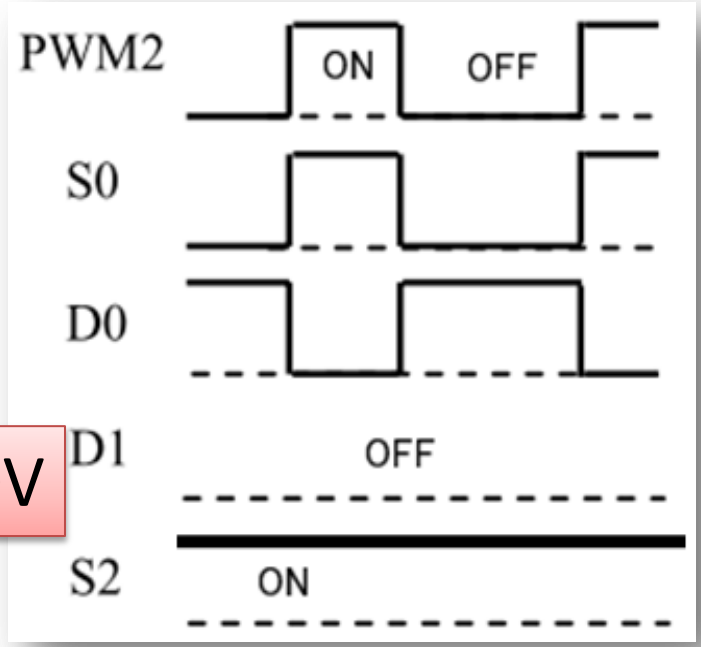
Proposed Control of SIDO with Two Buck Converters



Buck-Buck SIDO Converter

Converter 2 control





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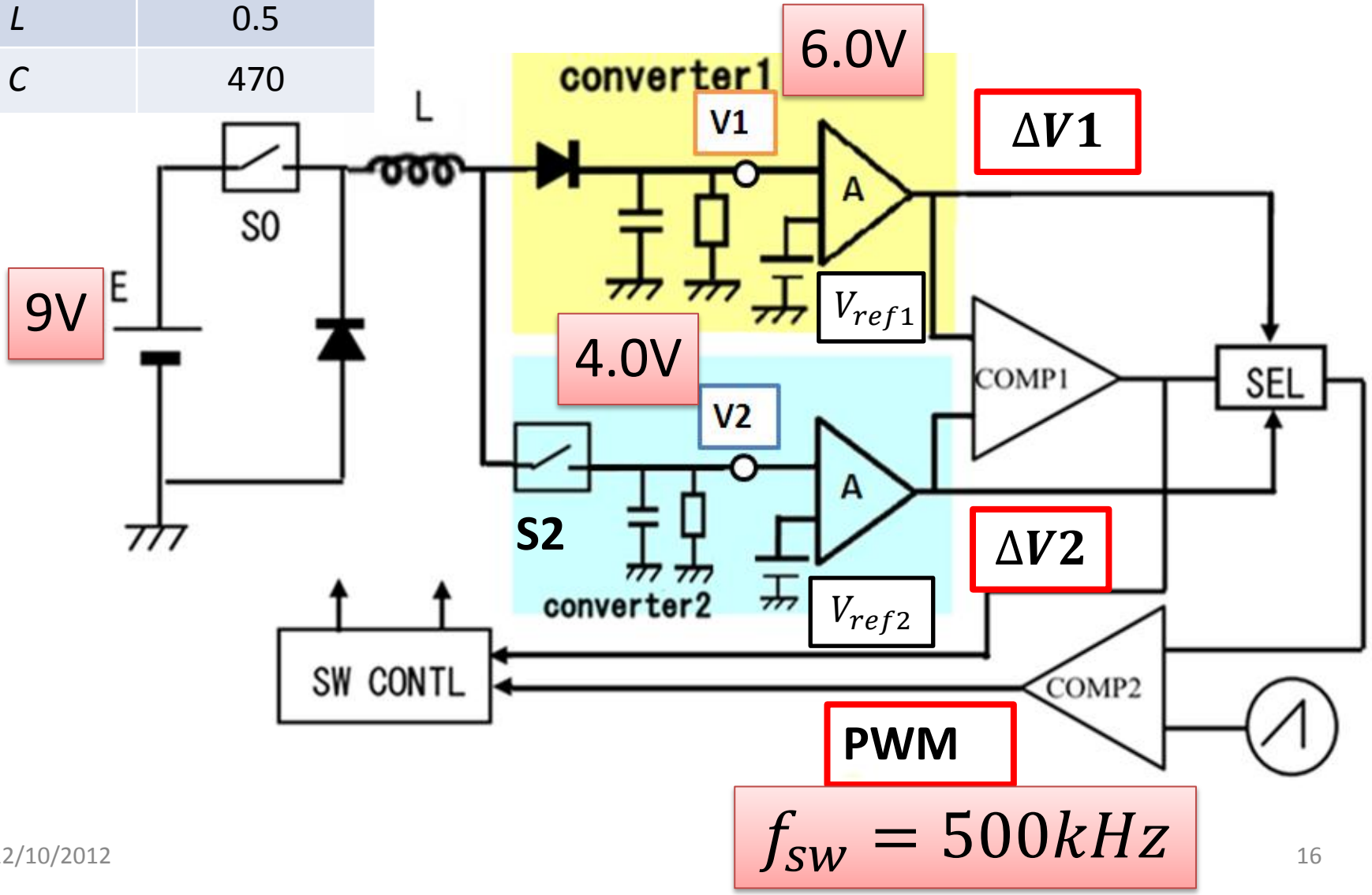
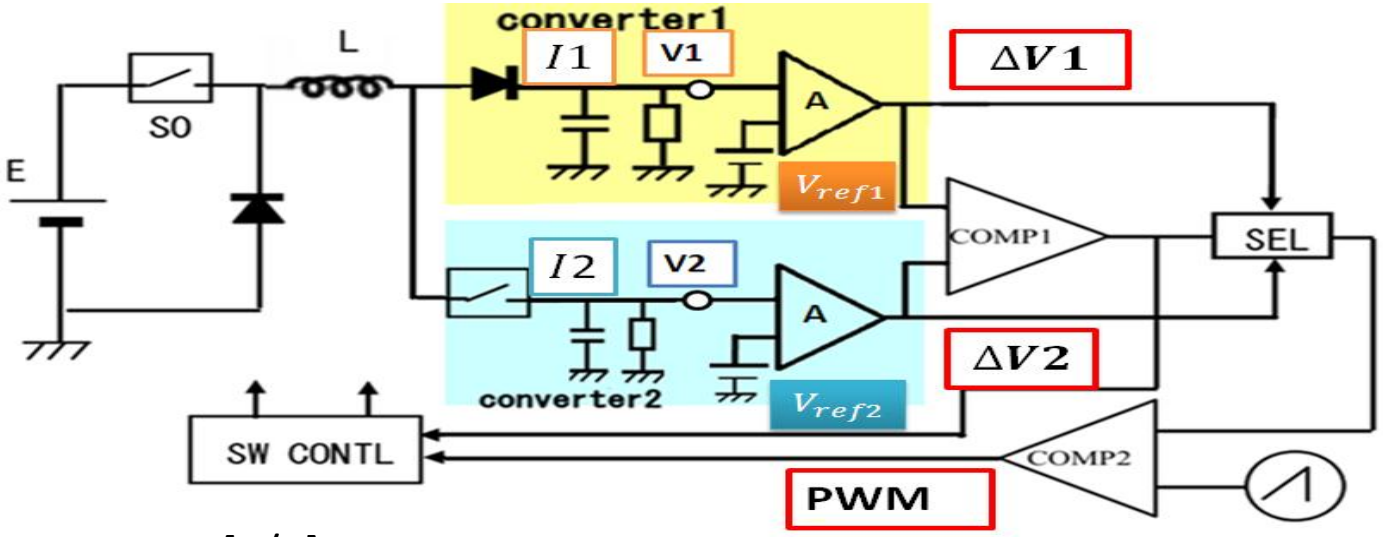
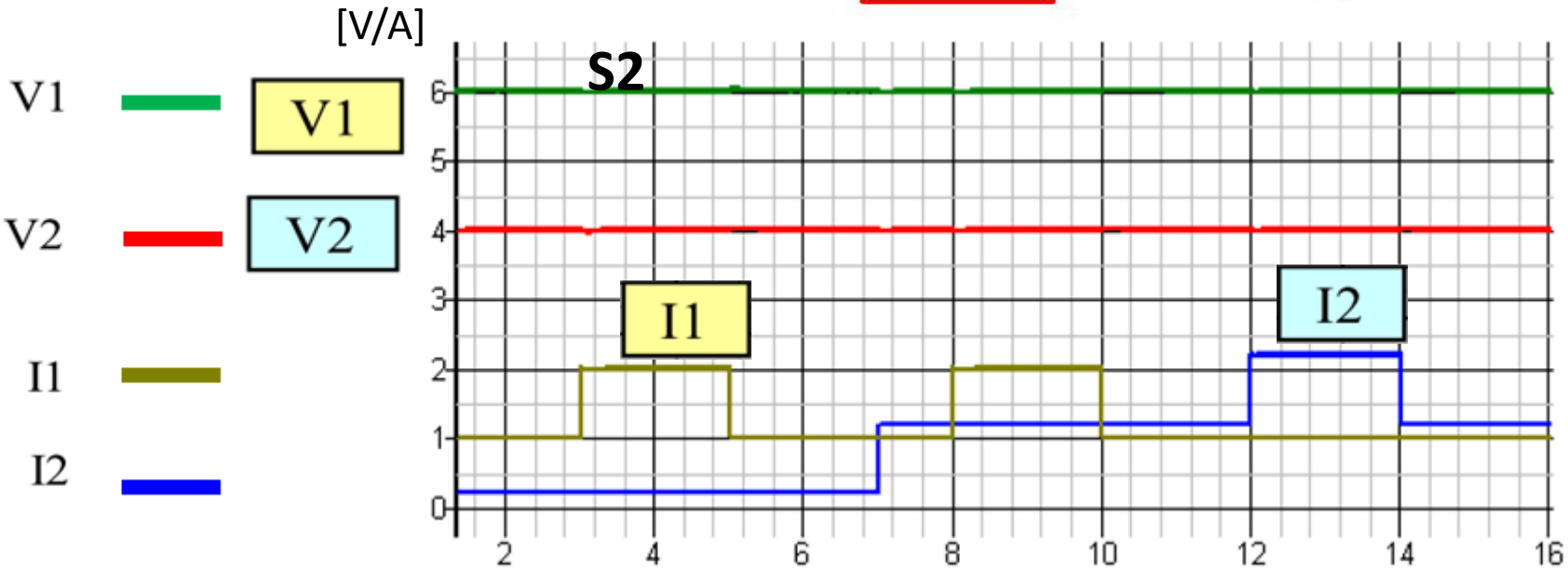
Proposed Buck-Buck Simulation

Parameter	Value
L	0.5
C	470



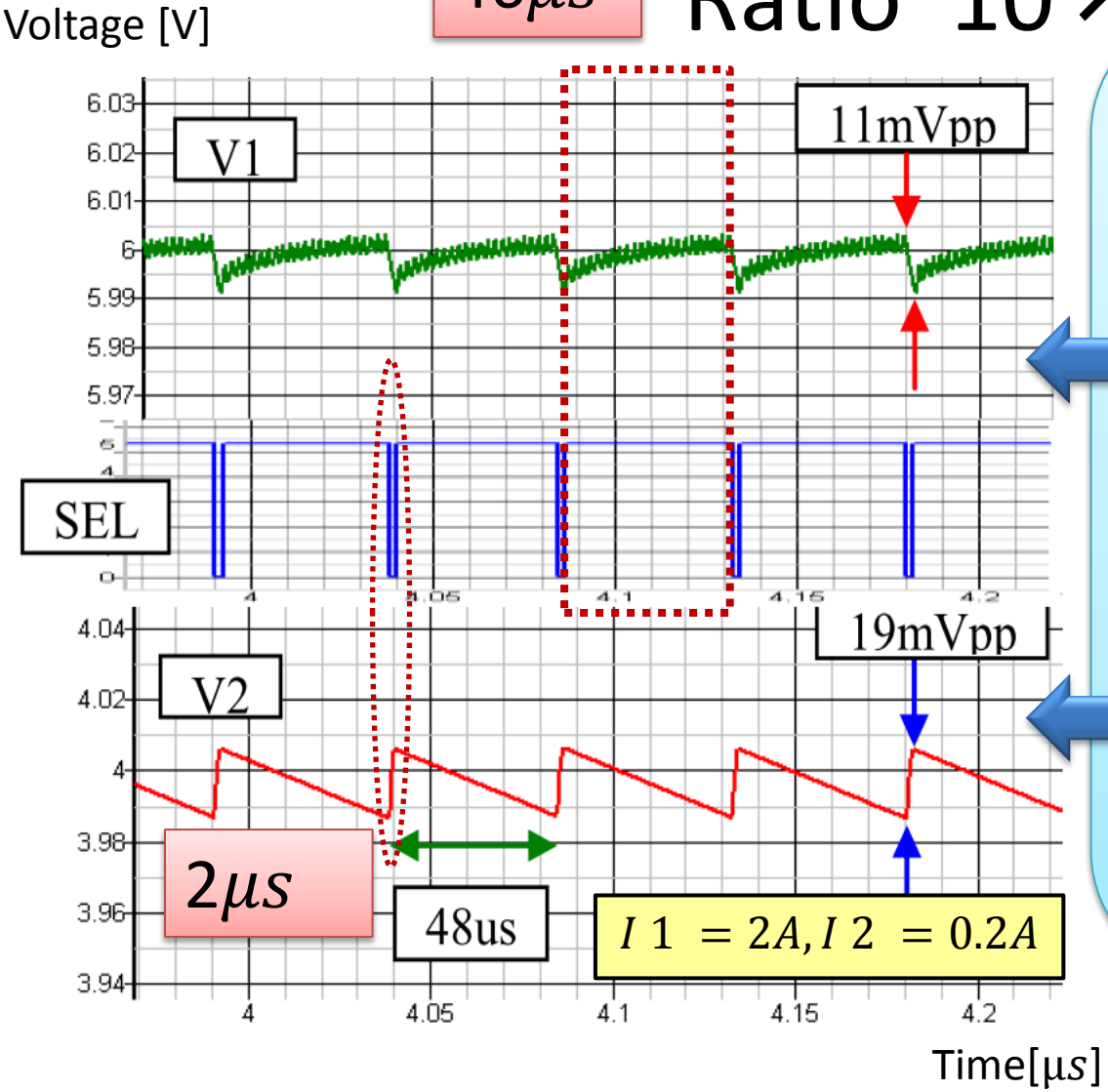
Simulation Results for Buck Converter





Output Ripple $\Delta V\,1$ and $\Delta V\,2$

$46\mu s$ Ratio 10 ×



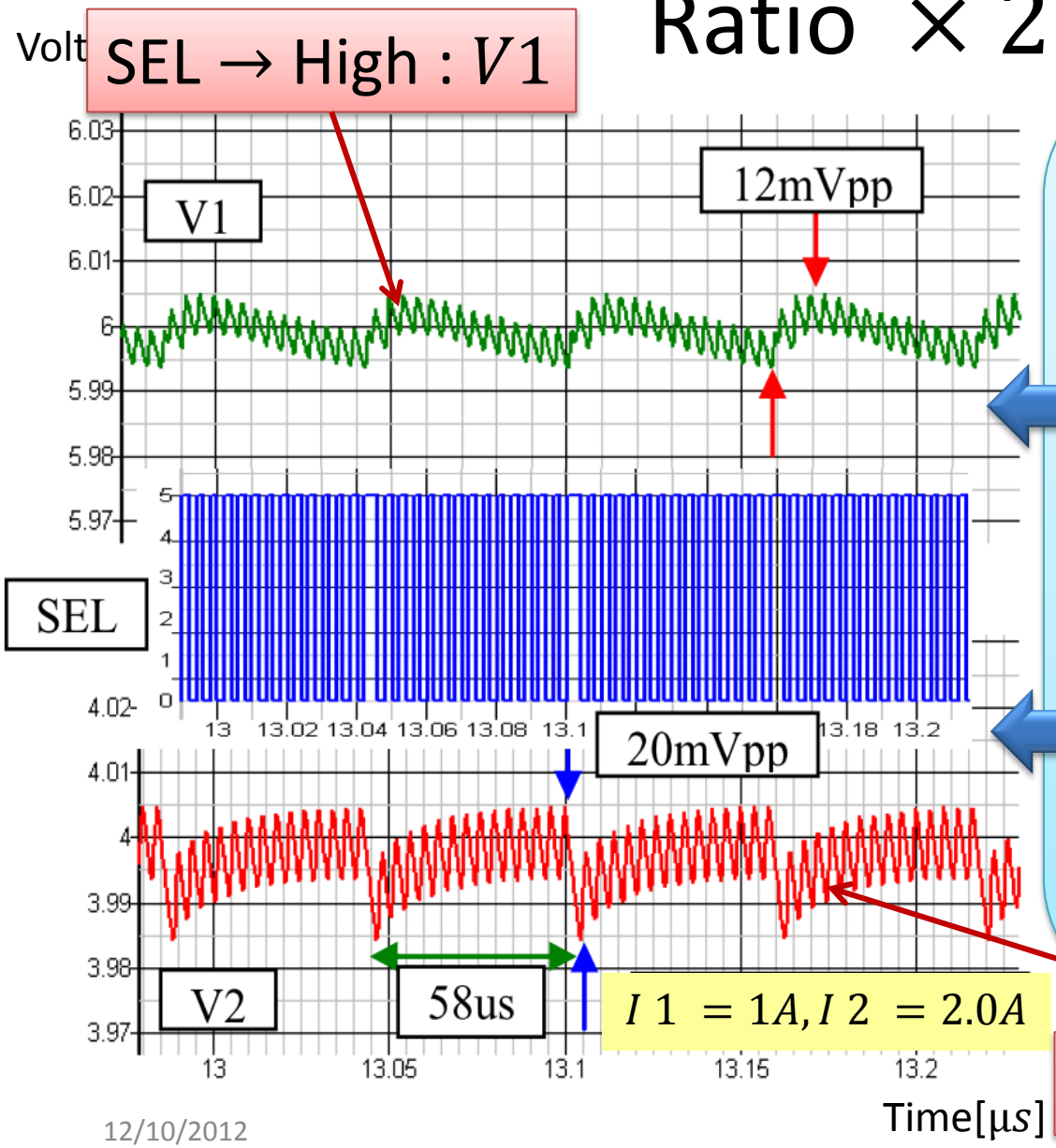
$I1 = 2A,$
$I2 =$0.2A

$\Delta V1 = 11mVpp$

$\Delta V2 = 19mVpp$

$\Delta V1, \Delta V2 < 0.5\%V_o$

Output Ripple ΔV 1 and ΔV 2 Ratio $\times$ 2.2



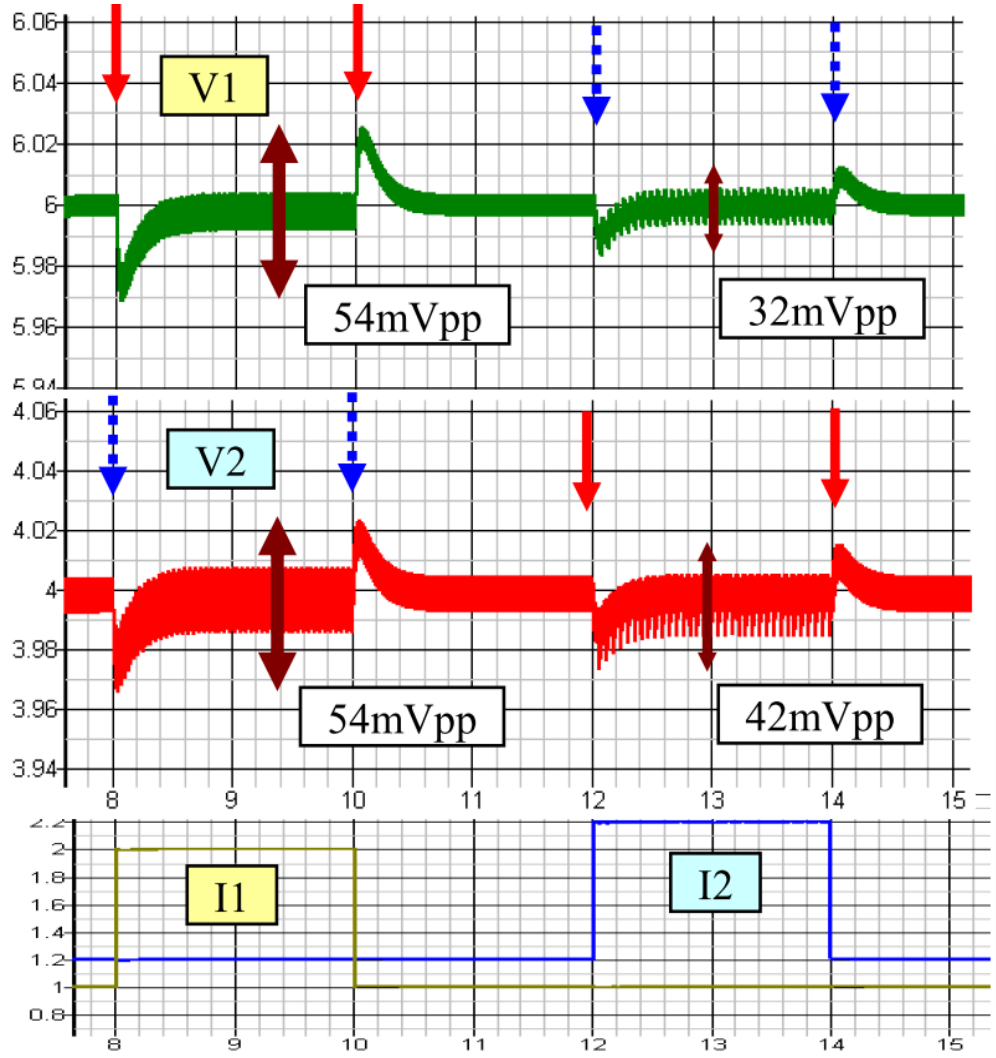
$I\ 1\ = 1A,$
$I\ 2\ = 2.2A$

$\Delta V1 = 12mVpp$

$\Delta V2 = 20mVPp$

$\Delta V1, \Delta V2 < 0.5\%V_o$

Transient Responses V 1 and V 2



Buck Converter

Red :self regulation:

ΔV_{SR}

Blue :cross regulation:

ΔV_{CR}

$\Delta V_{SR} \cong \Delta V_{CR} < 55mVpp$

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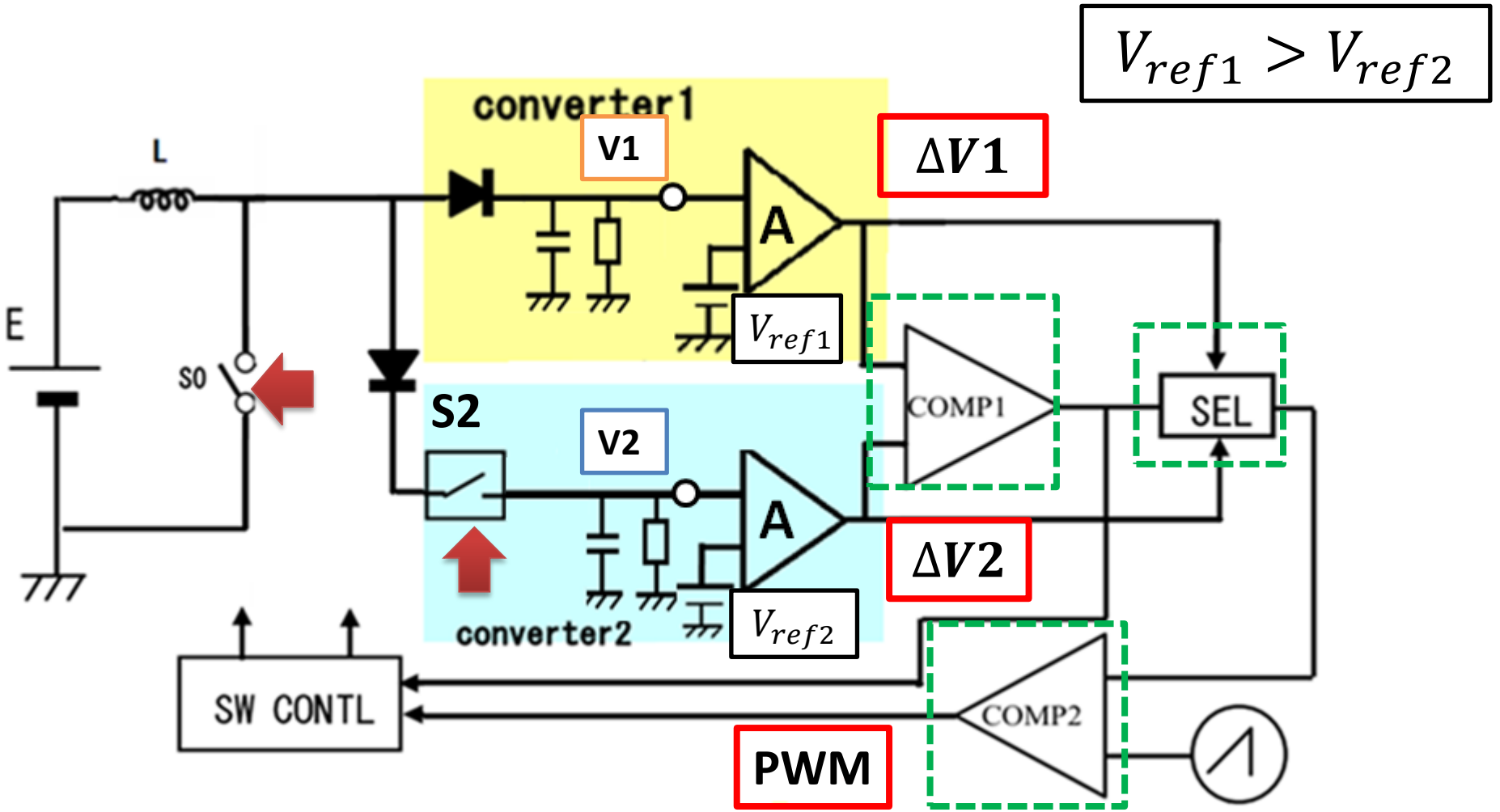
Proposed Control of SIDO with Two Boost Converters



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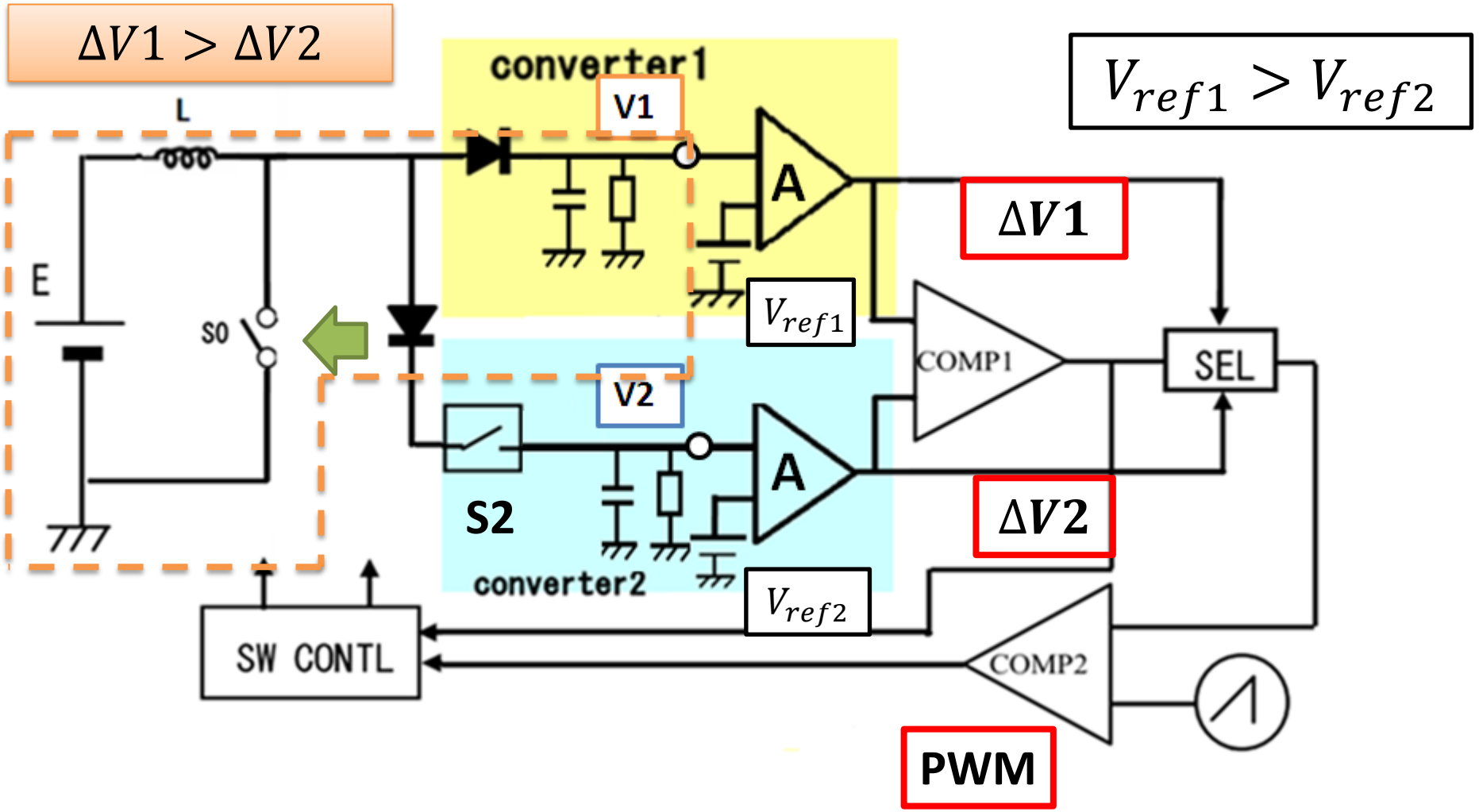
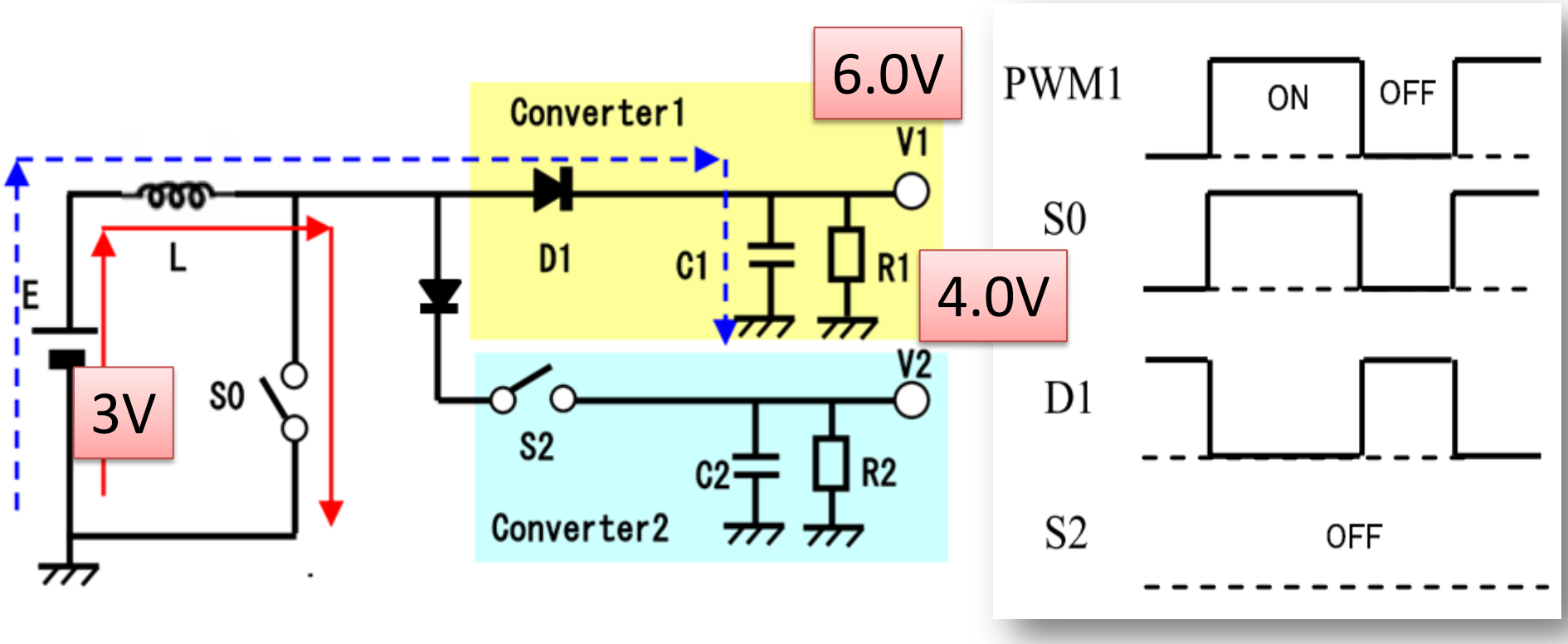
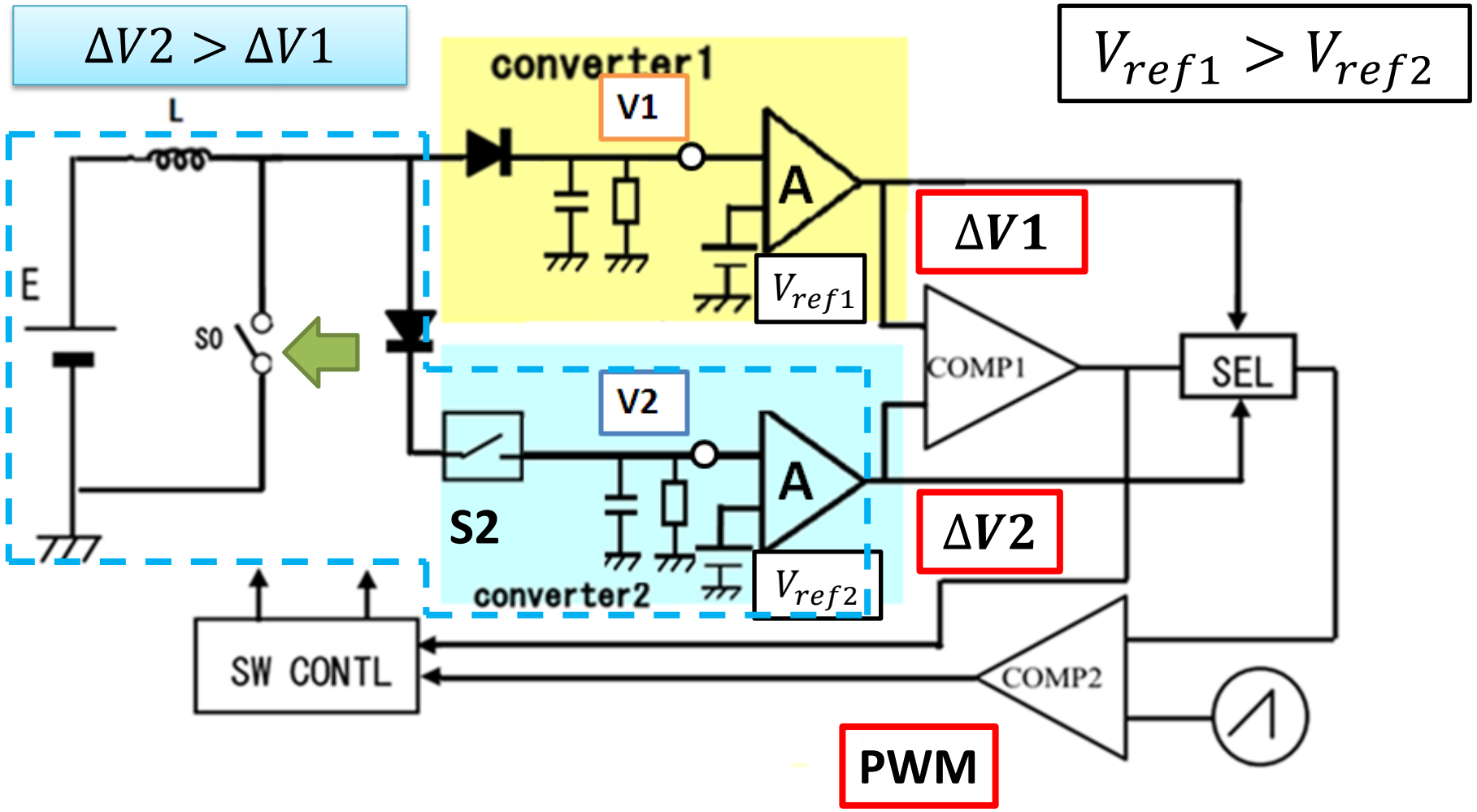


Boost-Boost Converter

Converter 1 control

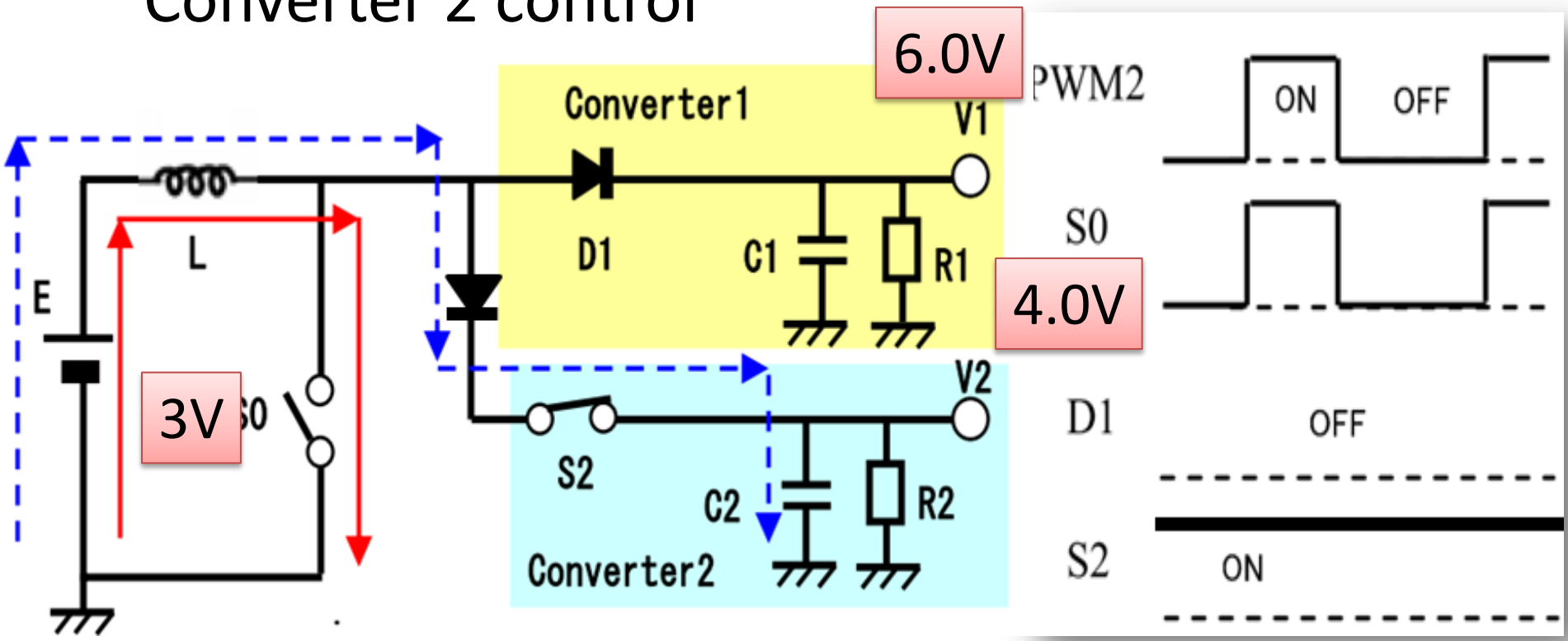


Proposed Control of SIDO with Two Boost Converters



Boost-Boost Converter

Converter 2 control



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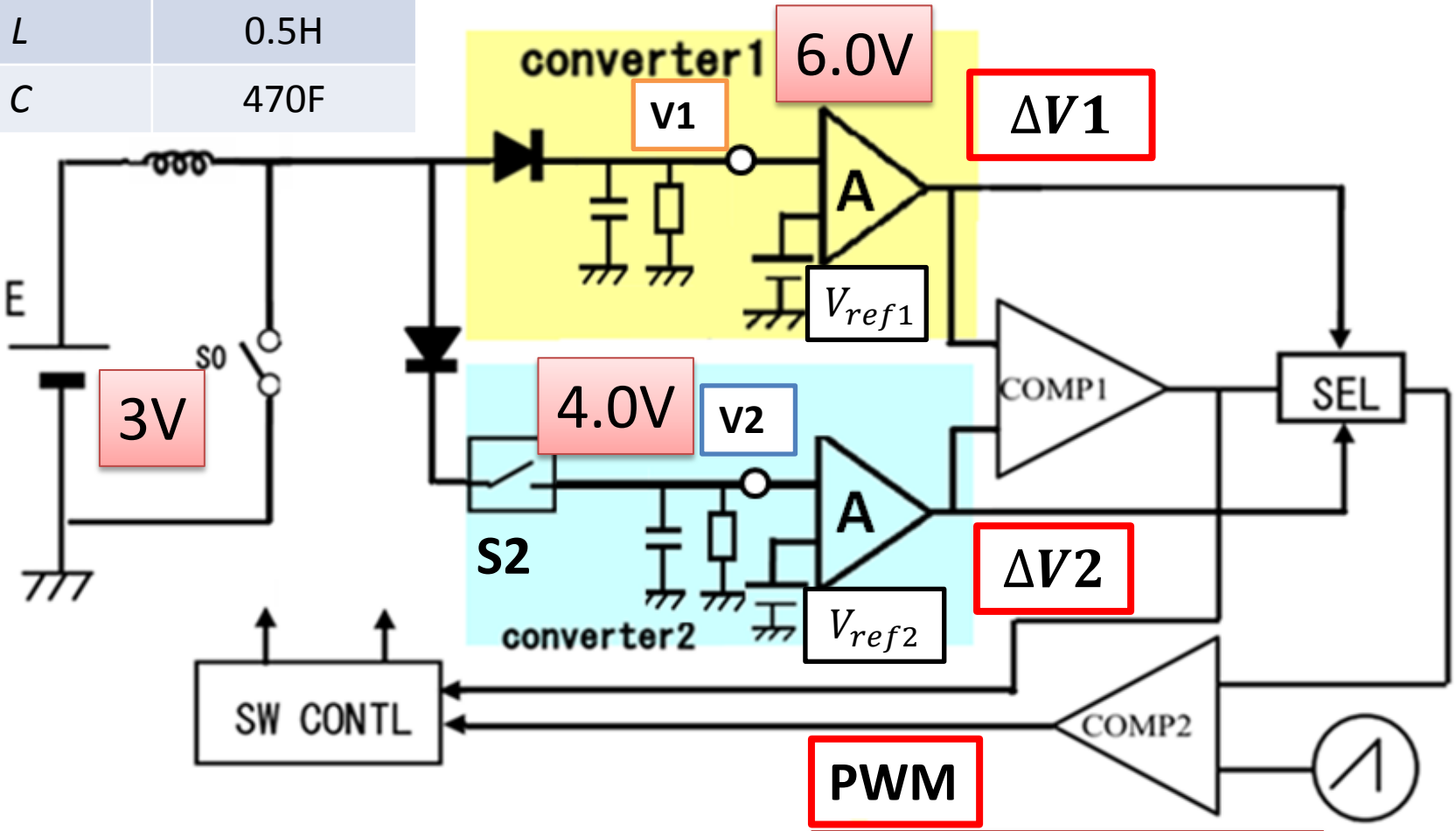
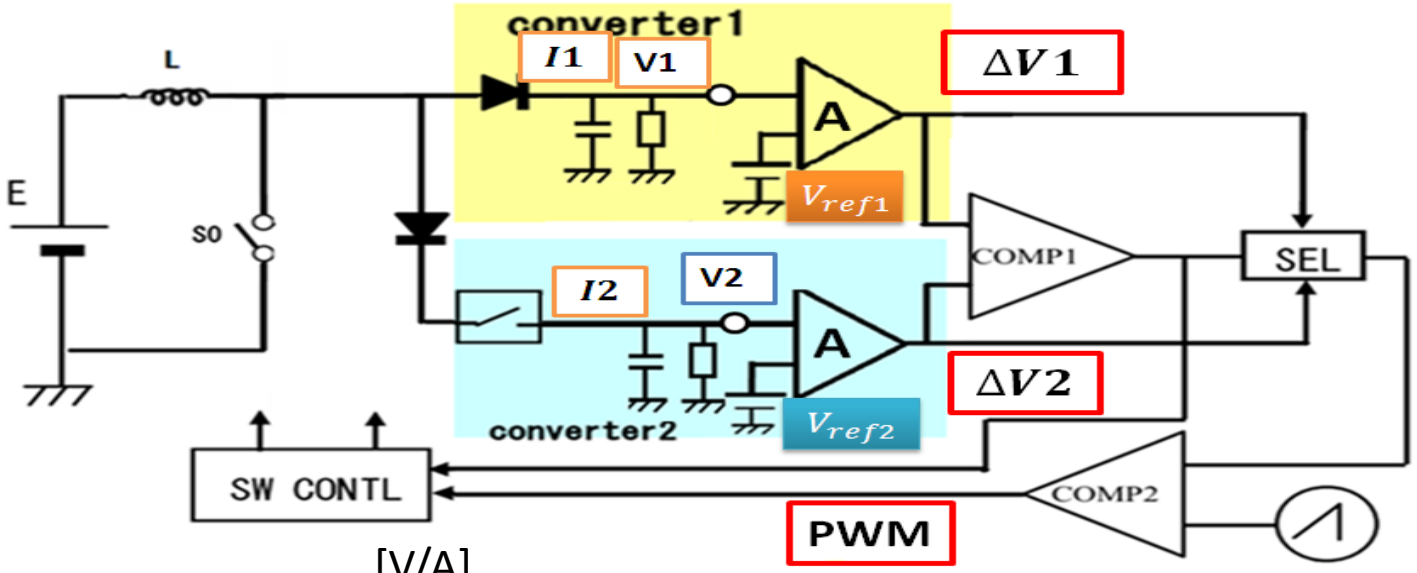
Proposed Boost-Boost Simulation

Parameter	Value
L	0.5H
C	470F

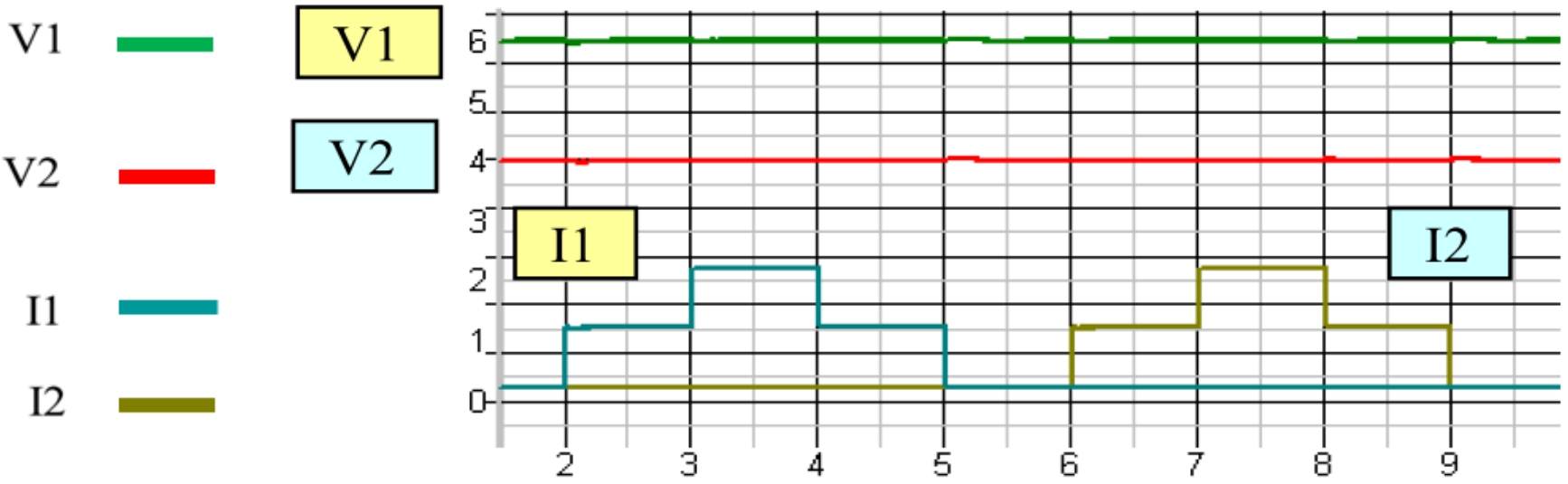


$$f_{sw} = 500kHz$$

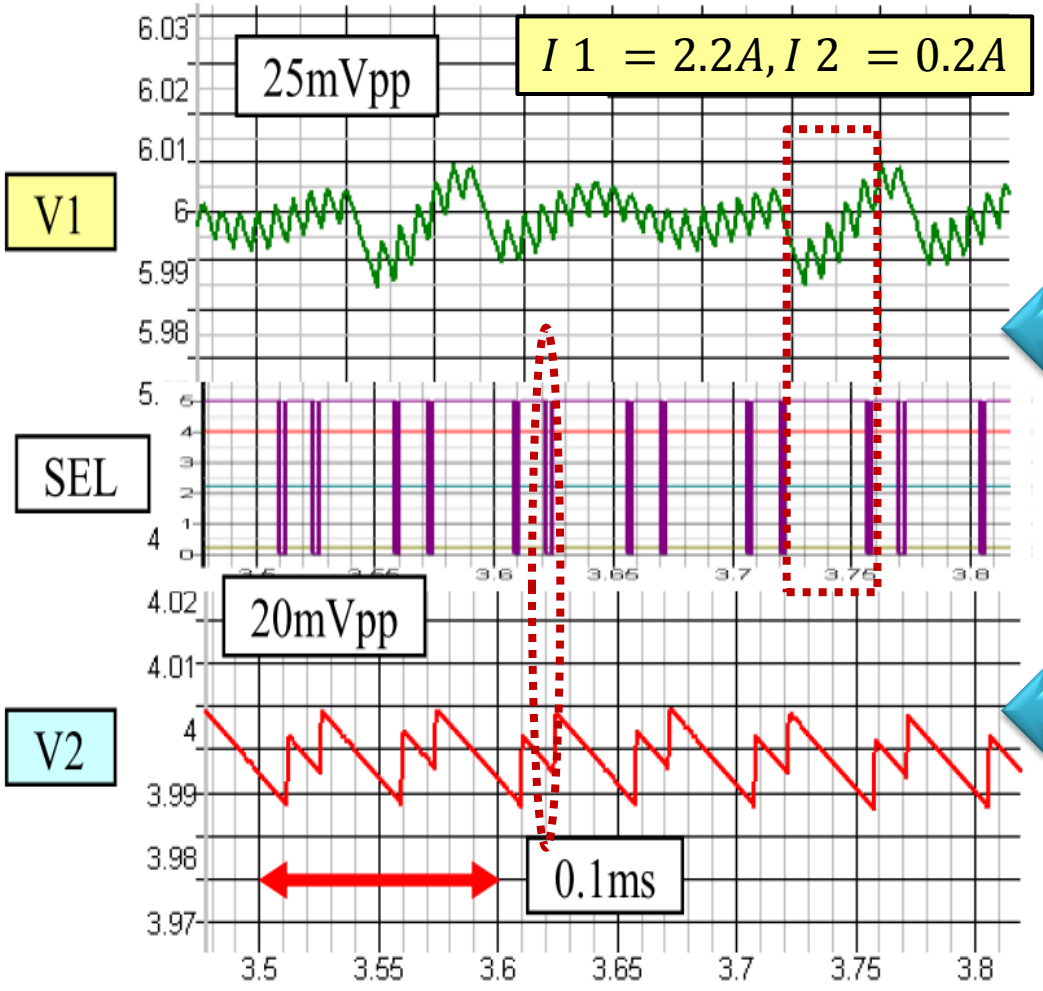
Simulation Results for Boost Converter



[V/A]



Output voltage ripple ΔV 1 and ΔV 2 Ratio ×11



$$I\,1 = 2.2A,$$
$$I\,2 = 0.2A$$

$$\Delta V1 = 25mVpp$$

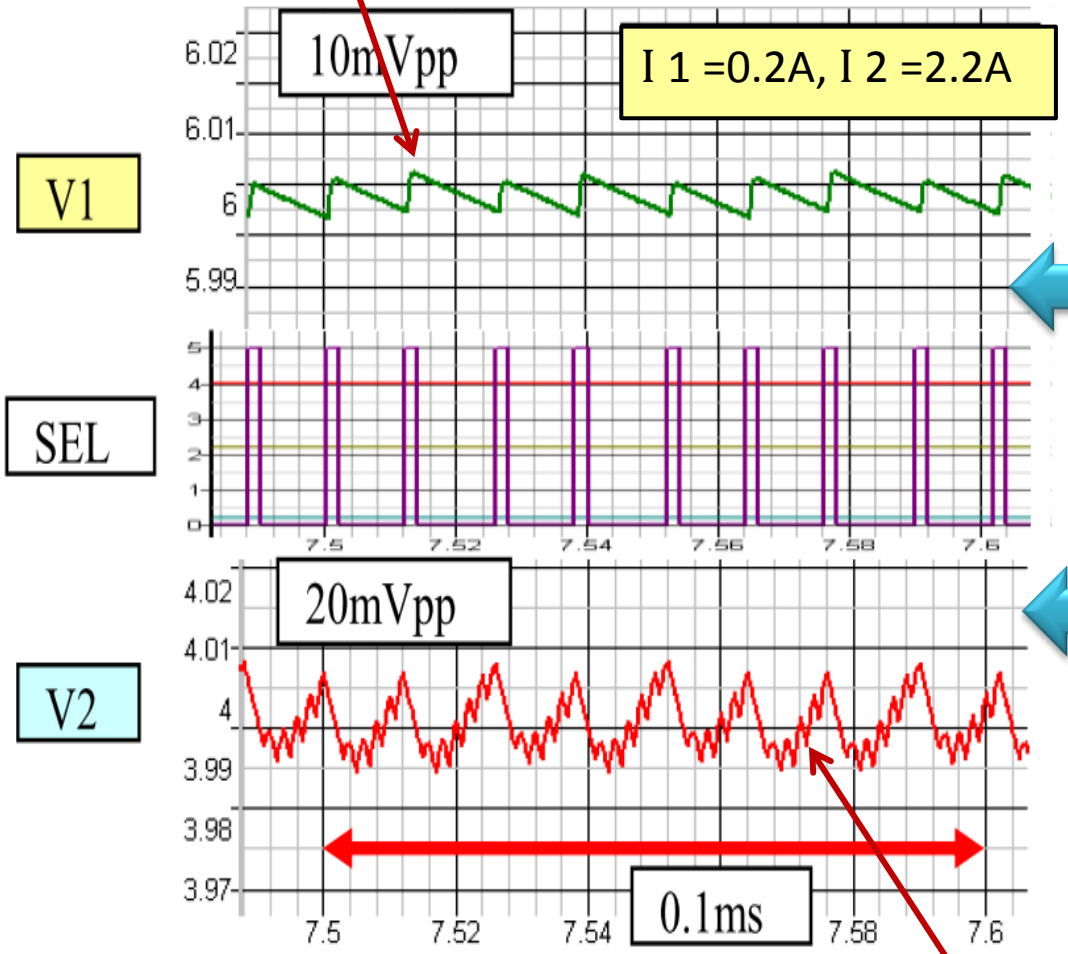
$$\Delta V2 = 20mVpp$$

$$\Delta V1, \Delta V2 < 0.4\%V_o$$

output voltage ripple ΔV 1 and ΔV 2

Ratio × 11

SEL → High : $V1$



$I\ 1\ = 0.2A,$

$I\ 2\ = 2.2A$

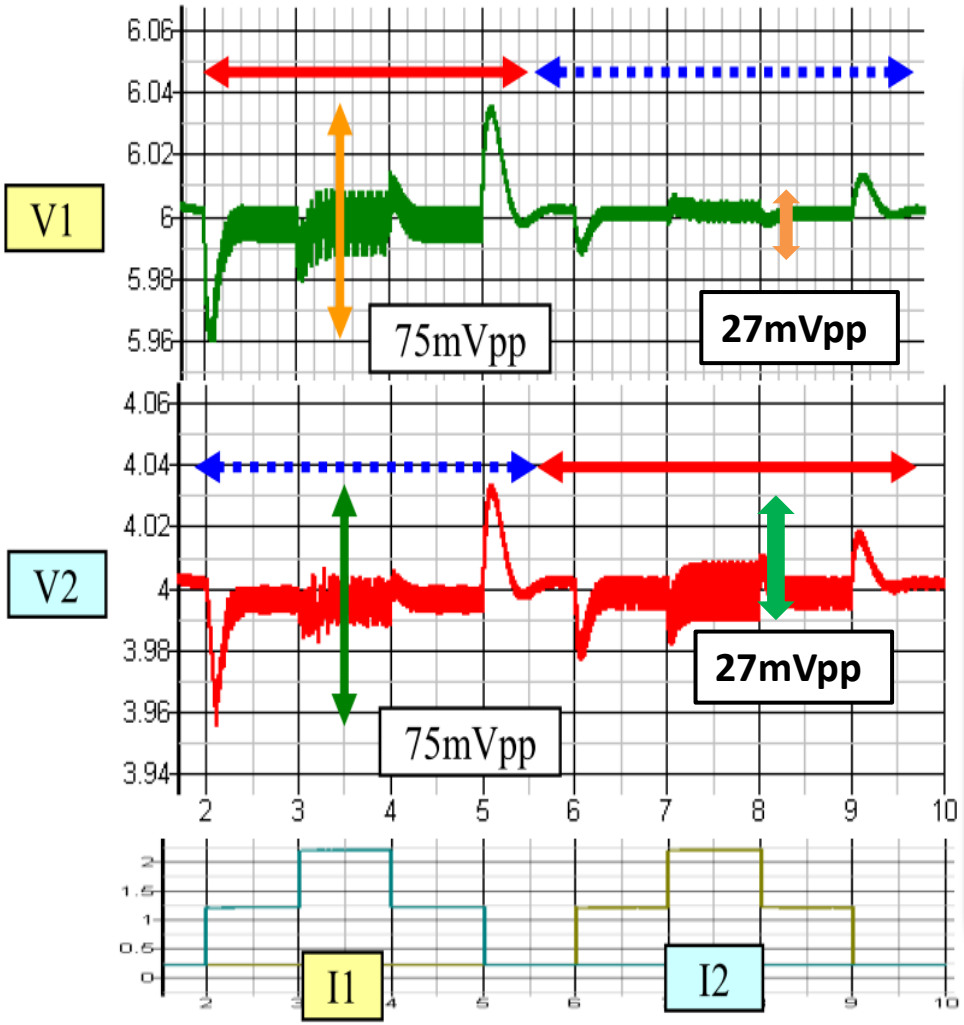
$\Delta V1 = 10mVpp$

$\Delta V2 = 20mVpp$

$\Delta V1, \Delta V2 < 0.4\%V_o$

SEL → Low : $V2$

Transient Responses V 1 and V 2



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Conclusion

- Single inductor dual output (SIDO) converter
- Proposed exclusive control
  - Simple control
  - Low cost control
- Verified its operation & performance with simulation