Transient response of Field Programmable Power Supply Array based on power SoC
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Introduction

Market demand of power supply
• Reduction in Size and Weight
• High efficiency
• High speed response
• Reduction in Cost

Power SoC’s Advantages
1. Size and weight reduction
2. High efficiency
3. Cost reduction ⇔ Mass production like LSI
4. High performance ⇔ Stable operation and efficient use of space

Challenges and Approaches
1. Small power capacity
2. High-frequency switching (≥ 10MHz)

Power SoC based on parallel connections of many dc-dc converters

Circuit configuration and Control algorithm

Circuit configuration

Input 5V

Buck converters

Output 1.2V

Power Device

Power SoC

Parallel connections

New control instead of PWM

Control algorithm

V_{set}: Target Voltage
V_N: Hysteresis (preventing oscillation)

Results

Load characteristic

Efficiency characteristic

Experiments

Obtained a constant output voltage
Keeping high efficiency over wide range

Simulations

Transient response of experiments

Simulation by Matlab Simulink

Transient response is dependent on switching frequency

Block diagram and Control method

Block diagram[1]

Control method[2]

Switching number N in response to output current

Formula

Block diagram and Control method

Full digital control ⇒ Rewriting 4 digital code without adjustment

High-speed response realized through increasing switching frequency

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Power SoC's Advantages
- Cost reduction
- Size and weight reduction
- Small power capacity
- High performance

Challenges and Approaches
- Small power capacity
- High-frequency switching (≥ 10MHz)
- Power SoC based on parallel connections of many dc-dc converters

Challenges
- Small power capacity
- High-frequency switching (≥ 10MHz)

Approaches
- Power SoC based on parallel connections of many dc-dc converters

Ultimate miniaturization = One chip POL

Block diagram and Control method

Block diagram

Control method

Switching number \( N \) in response to output current

Formula

Buck converter

\[ V_{\text{out}} = D V_{\text{in}} \frac{r}{N} I \]

Boost converter

\[ V_{\text{out}} = \frac{1}{1 - D} V_{\text{in}} - \frac{r}{N} I \]

- Only rewriting of digital code, it can be multiple input and output
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Results

◆ Load characteristic

- N=1
- N=2
- N=3
- N=4
- N=5
- Control (+)
- Control (-)

◆ Efficiency vs. Load current

- No=1
- Control

◆ Transient response Simulation by Matlab Simulink

- Obtained a constant output voltage
- Keeping high efficiency over wide range
- Transient response time is dependent on switching frequency