Automotive 48V and MPS Solutions

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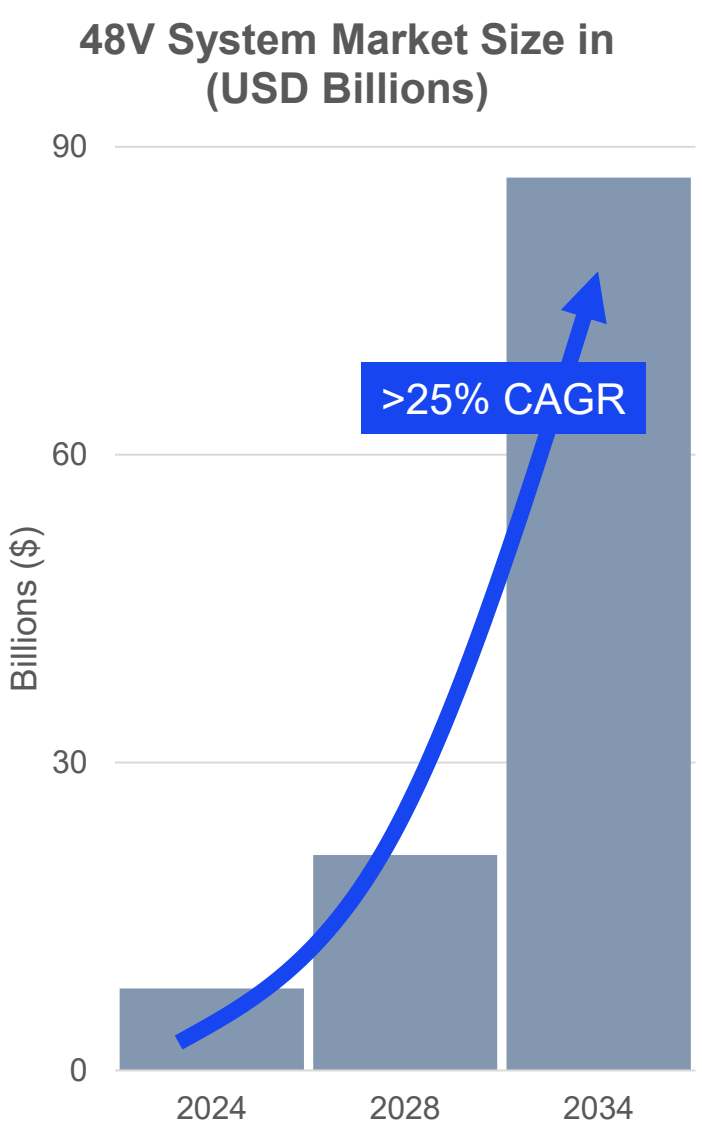
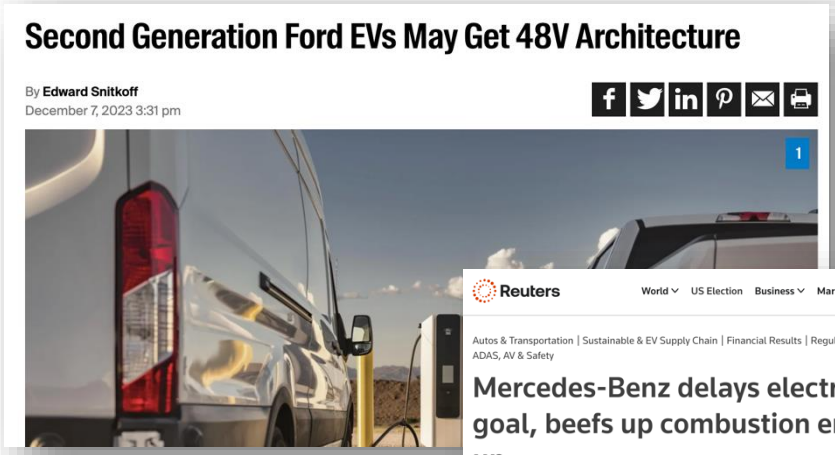
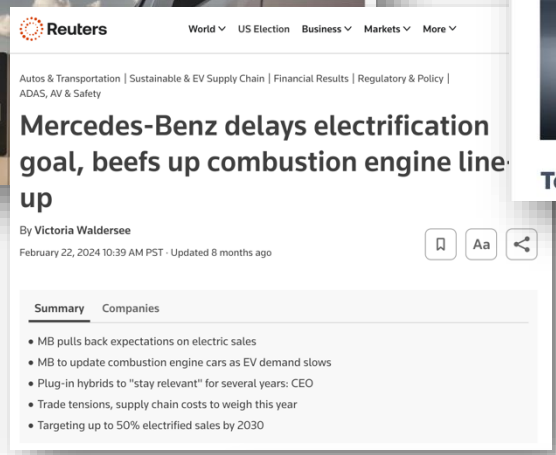
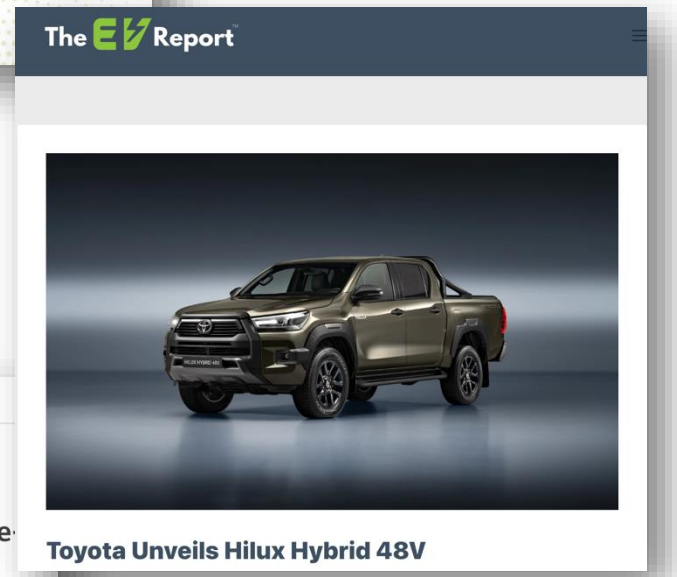
2025.8

Automotive 48V Market Entering Mainstream







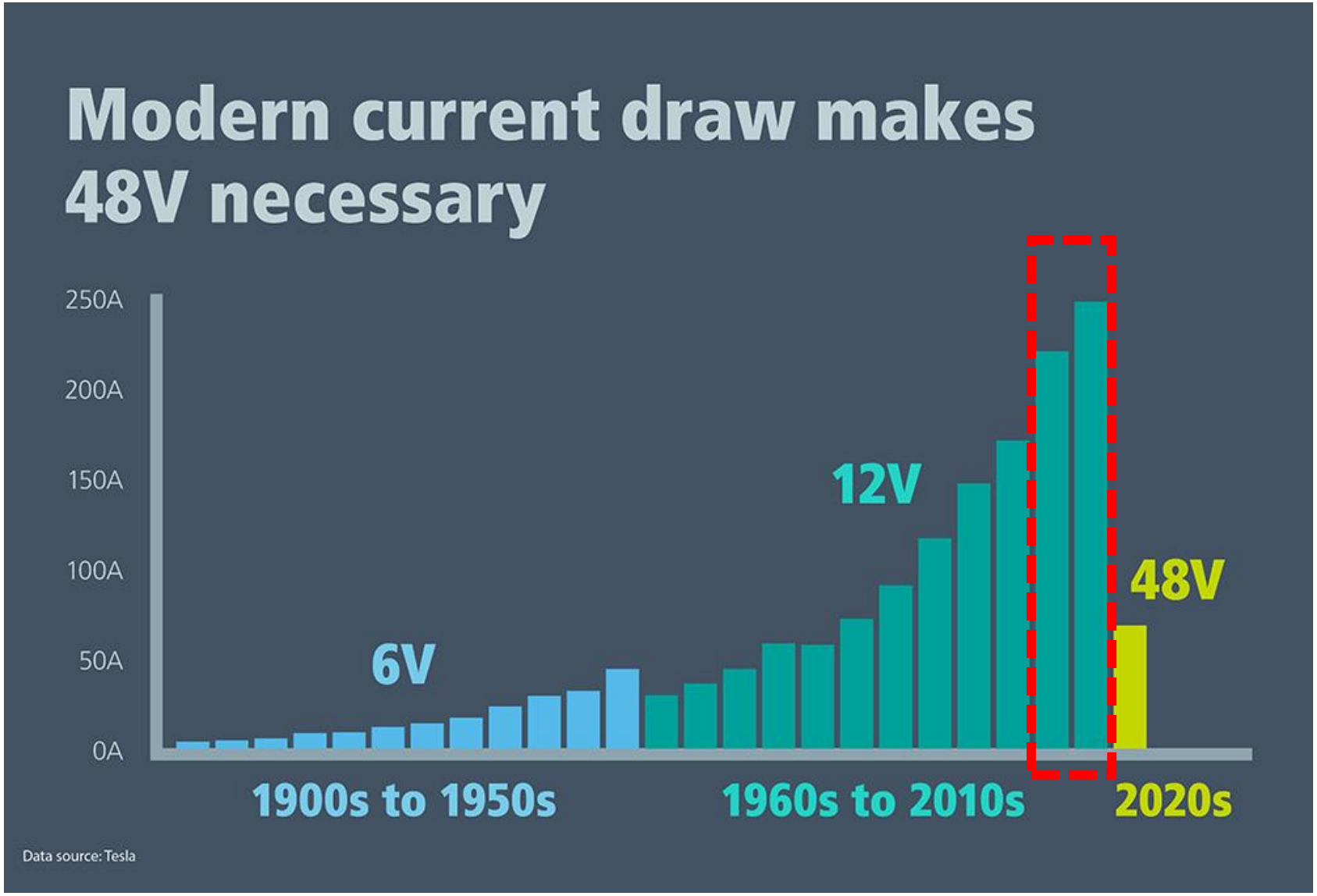


Source: Precedence Research, Automotive 48V System Market Size August 2024

Why 48V?

Why 48V?

Higher power required by EVs



Increasing Load Power:

- ***Drive-by-Wire***

~2kW

- ***Higher Power SoC (ADAS, Cockpit, AI Box…)***

~1kW

- ***Active Suspension System***

~1-2kW

…

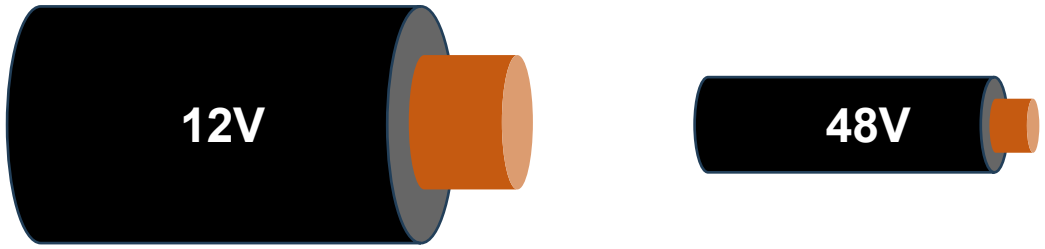
48V is necessary!

Data source: Tesla

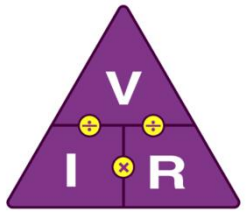
Why 48V?

Lower power loss/weight/cost

600W Load Example



50 Amps		**12.5** Amps
10 mm^2		**1.5** mm^2
108 grams/meter	Kg	**17** grams/meter
4.5 Watts/meter		**1.9** Watts/meter



Ohm's Law

» 80%
Smaller size

» 80%
Weight reduction

» 50%
Less loss in wiring

Why 48V?

Why not higher than 48V?

1) GB/T18384.3

4 电压等级

根据最大工作电压U,将电气元件或电路分为以下等级,如表1所示。

表1 电压等级 单位为伏

电压等级	最大工作电压	
	直流	交流(rms)
A	$0 < U \leqslant 60$	$0 < U \leqslant 30$
B	$60 < U \leqslant 1\,500$	$30 < U \leqslant 1\,000$

2) ECE-R100.03

2.42. "*Specific voltage condition*" means the condition that the maximum voltage of a galvanically connected electrical circuit between a DC live part and any other live part (DC or AC) is ≤ 30 V AC (rms) and ≤ 60 V DC.

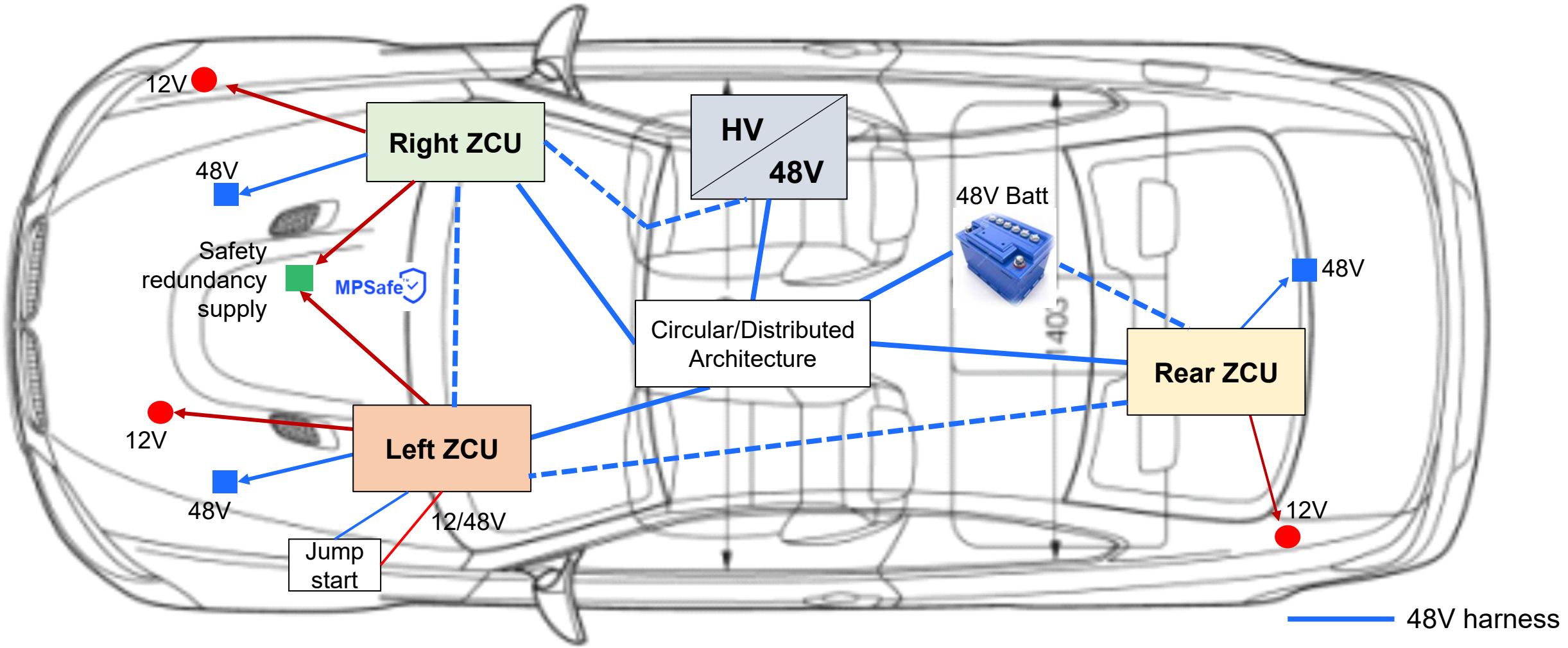
Note: When a DC live part of such an electrical circuit is connected to chassis and the specific voltage condition applies, the maximum voltage between any live part and the electrical chassis is ≤ 30 V AC (rms) and ≤ 60 V DC

UNITED NATIONS

- 60V DC is a safety limit voltage for human;
- If higher than 60V DC bus, insulation or isolation needed to be considered in design

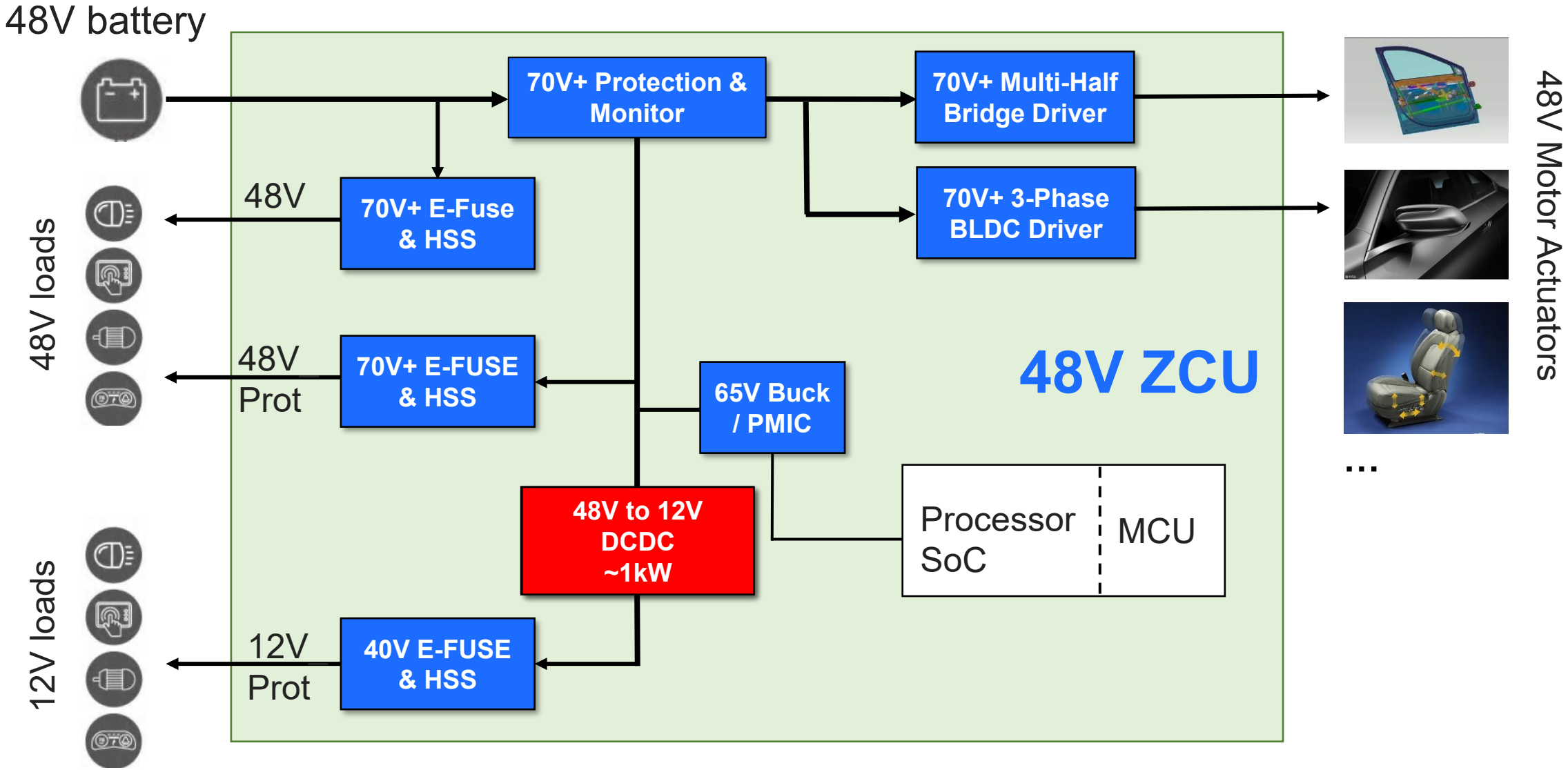
48V EV Structure & Zonal Control Unit

Architecture of 48V System-Zonal



- ZCUs are classified by position;
- Short wire: low cost, light weight, simple assembly;
- Safety: key components have redundant power;

Architecture of 48V Zonal Control Unit



MPS has overall sockets solution in 48V ZCU

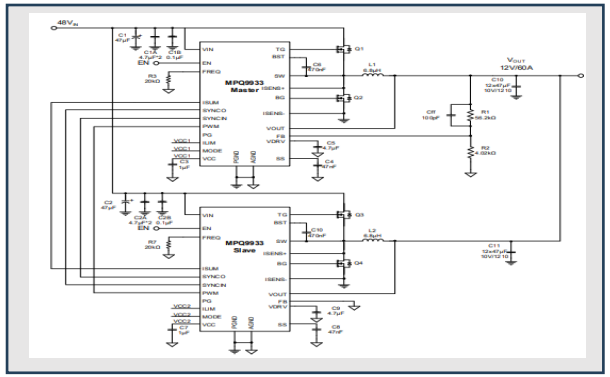
48V to 12V DCDC in ZCU

48V ZCU High Power DCDC Requirement

- Small Size and high power
- High efficiency need up to 97%
- Bi-directional operation
- Output has no risk to see 48V
- Build in soft startup
- Rich protection

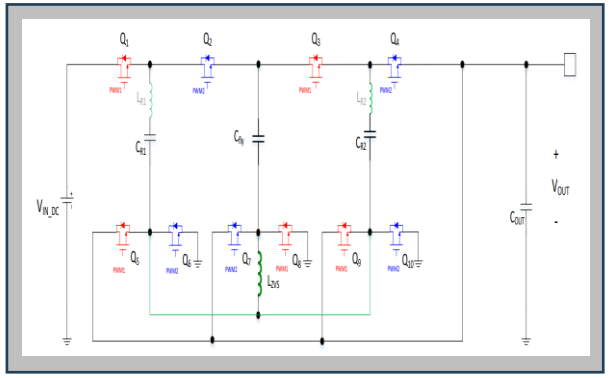
Topology for High Power DCDC

Multi-Phase Buck



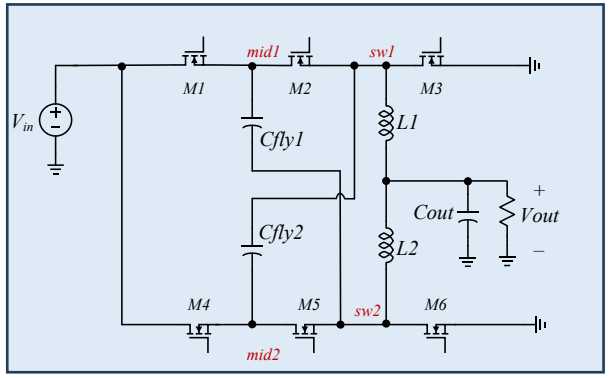
- Small Size and high power ✗
- High efficiency need up to 97% ✓
- Bi-directional operation ✗
- Output has no risk to see 48V ✗
- Build in soft startup ✓
- Rich protection ✓

Switch cap



- Small Size and high power ✓
- High efficiency need up to 97% ✓
- Bi-directional operation ✓
- Output has no risk to see 48V ✗
- Build in soft startup ✗
- Rich protection ✗

Hybrid buck



- Small Size and high power ✓
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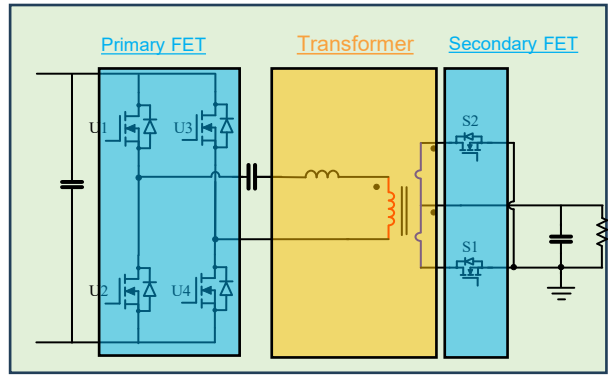
- Bi-directional operation ✗
- Output has no risk to see 48V ✗
- Build in soft startup ✓
- Rich protection ✓

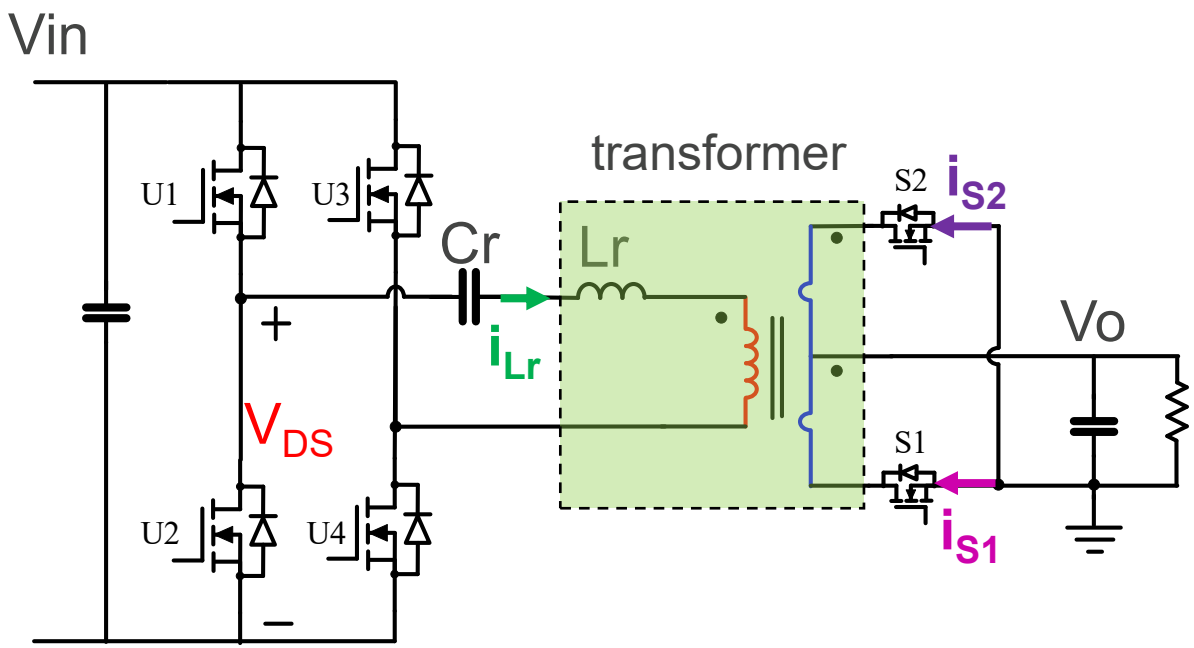
Open Loop LLC

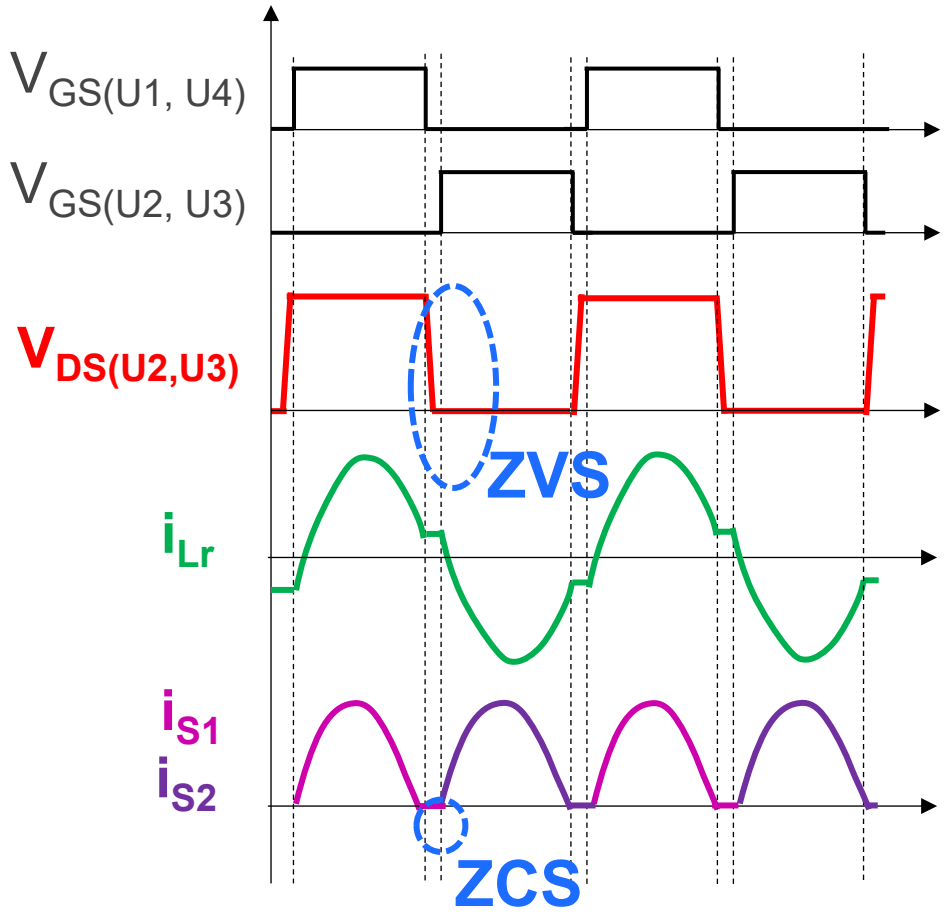


- Small Size and high power ✓
- High efficiency need up to 97% ✓
- Bi-directional operation ✓
- Output has no risk to see 48V ✓
- Build in soft startup ✓
- Rich protection ✓

Open Loop LLC topo is the best solution for the ZCU power supply

MPS LLC Power DCX





Soft switching: ZVS+ZCS

- High efficiency, high power density, low EMI
- Primary mos damage, secondary output can’t see high voltage

MPC1230X

70V Non-Isolated/Isolated LLC-DCX

Features

- The power converter kit is a high-efficiency non-Isolated converter with a fixed 4:1 voltage ratio, operating from a 20-70V DC primary bus to 5-18V output voltage, and can deliver up to 1kW continuous power at a typical 48V input voltage

- Support up to 400W, 1,000W continuous power
- Fixed 2MHz or 470kHz switching frequency
- Support parallel connection of 3 kits to 3kW
- Built-in MTP
  - Soft-start
  - Programmable Input OVP/UVLO
  - Programmable Output OVP/UVP
  - Programmable OCP
  - Programmable OTP
- Power Good

Comprehensive diagnostic functionality

- Input and Output Voltage, Output Current, and Temperature Protection
- Input and Output Voltage, Output Current, and Temperature Monitoring

Robust Communication

- Support up to 1MHz frequency of I2C

Benefits of LLC converter kit:

- High Efficiency and High Power Density
- Bi-Directional Operation
- High Peak Power Capability
- ASIL B solution
- Low Iq mode

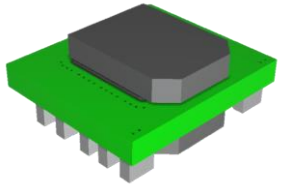
Thermal Enhanced 80V/40V Half Bridge & SR

- 85V /135A
- 40V/ 110A
- Ron: 3.6mohm/3.3mohm
- Thermal resistance: Rja=3.25C/W (with heatsink)
- DFN-8 5mmx6mm

Tuned 80V Driver IC

- Vin: 10V To 80V
- Driver: 2MHz operating frequency
- Ultra Fast
- QFN-10 4mmx4mm

Integrated Resonant Transformer



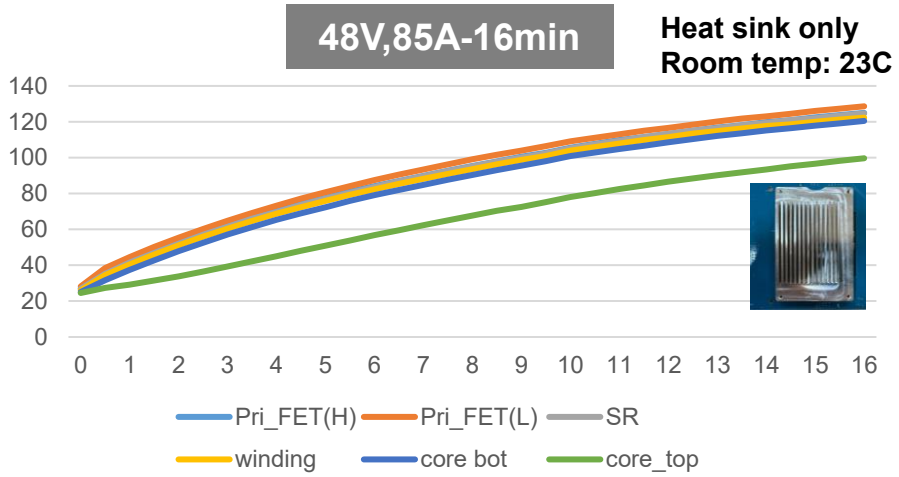
- Integrated Lm and Lr
- Optimized core loss, winding loss and rectifier loss
- SMT & Compact size
- 19.2mmx19.2mm

Tuned Control IC

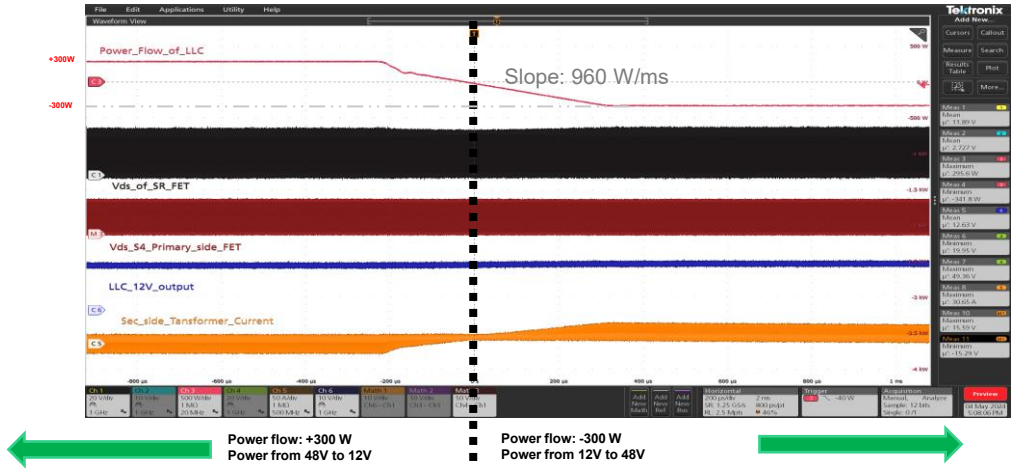
- Tuned frequency for resonant
- Tuned the dead time for soft switching
- Rich monitoring & protection
- QFN-24 4mmx4mm

MPS LLC Power DCX

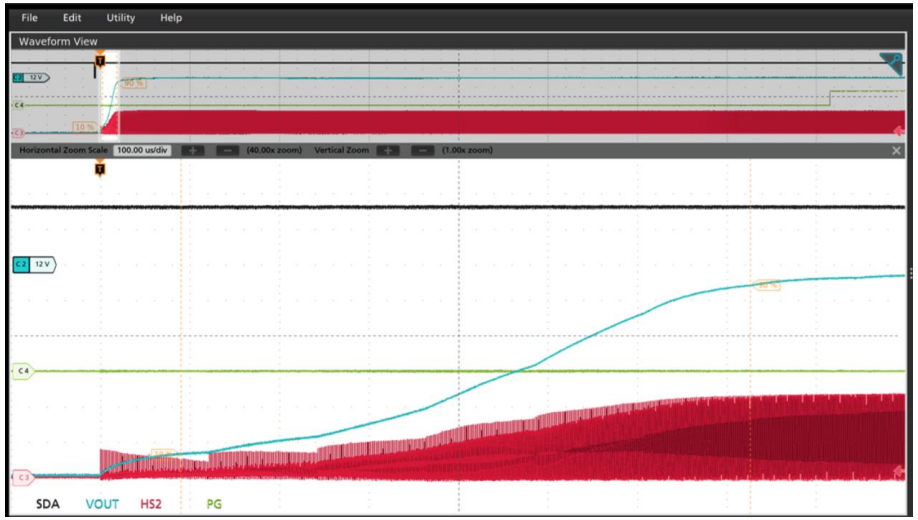
Thermal Performance



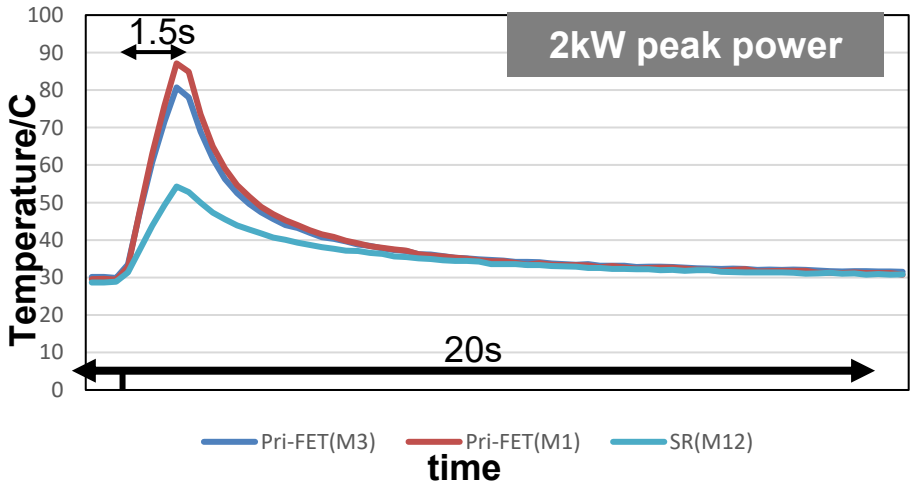
Bi-direction operation



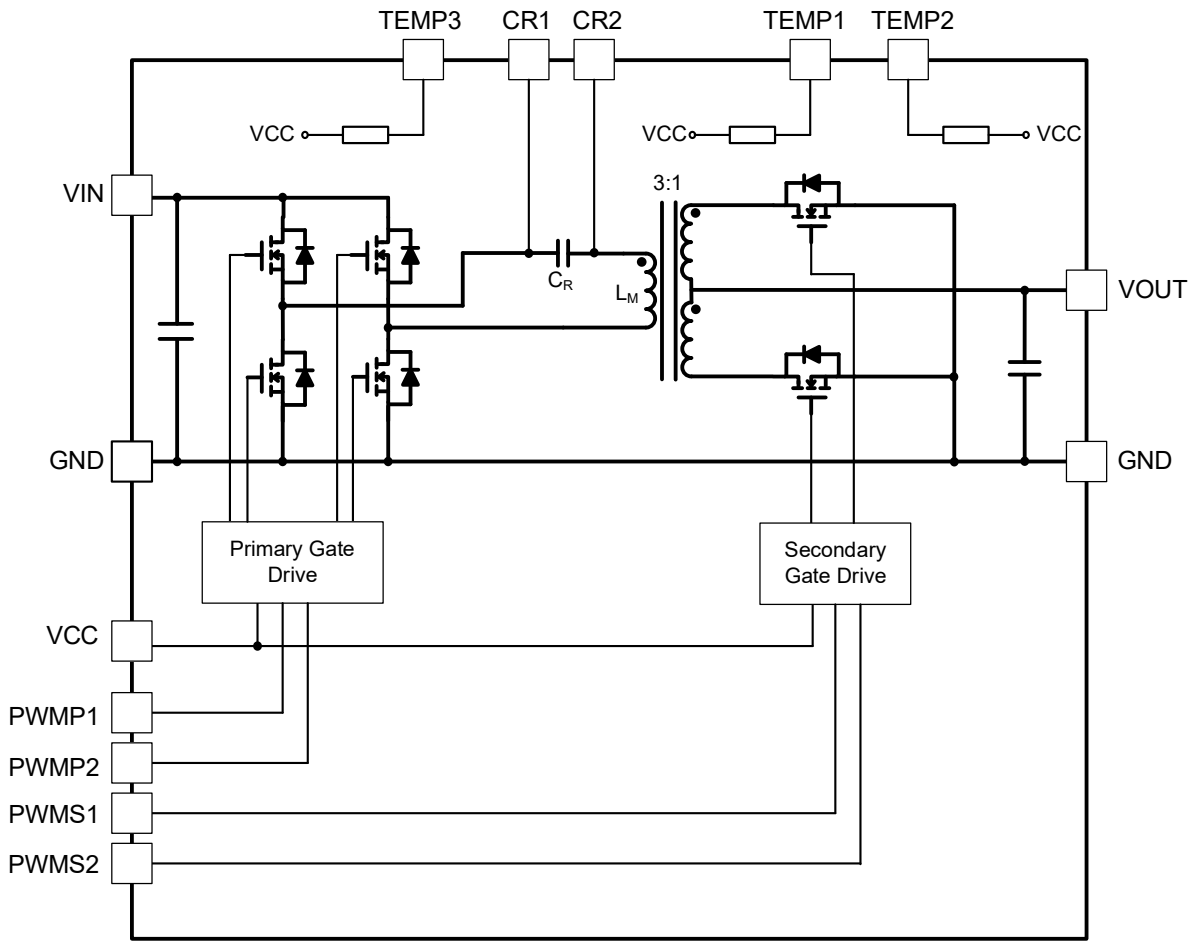
Build in Soft start

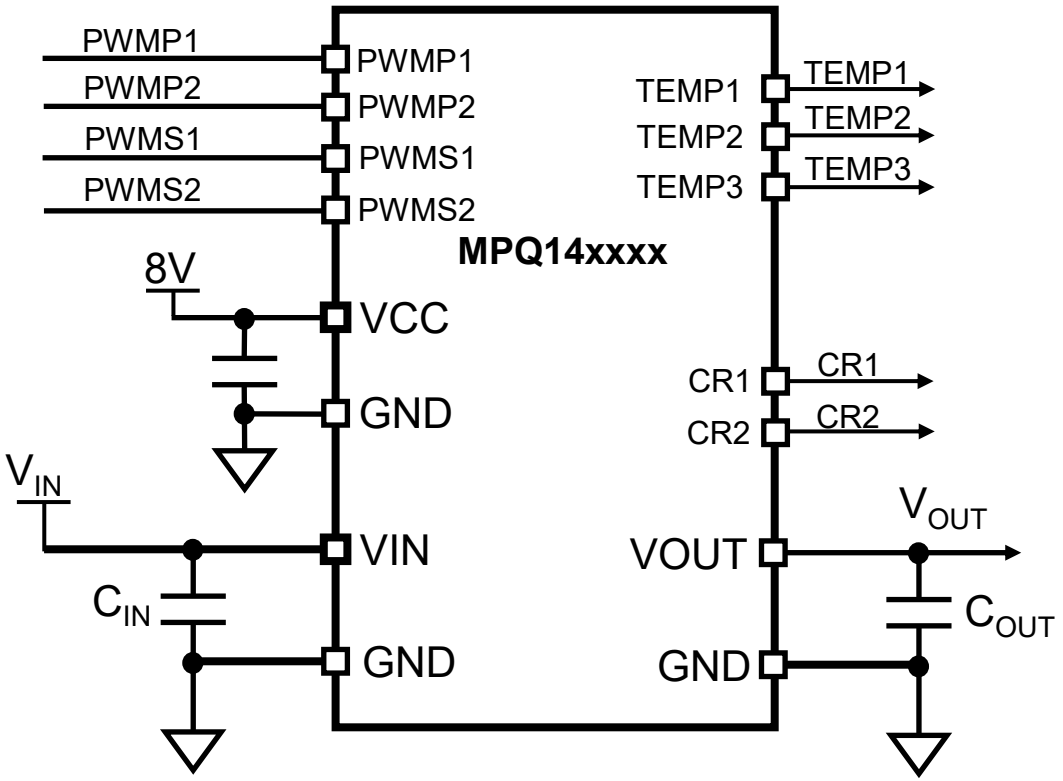


Peak Power Capability



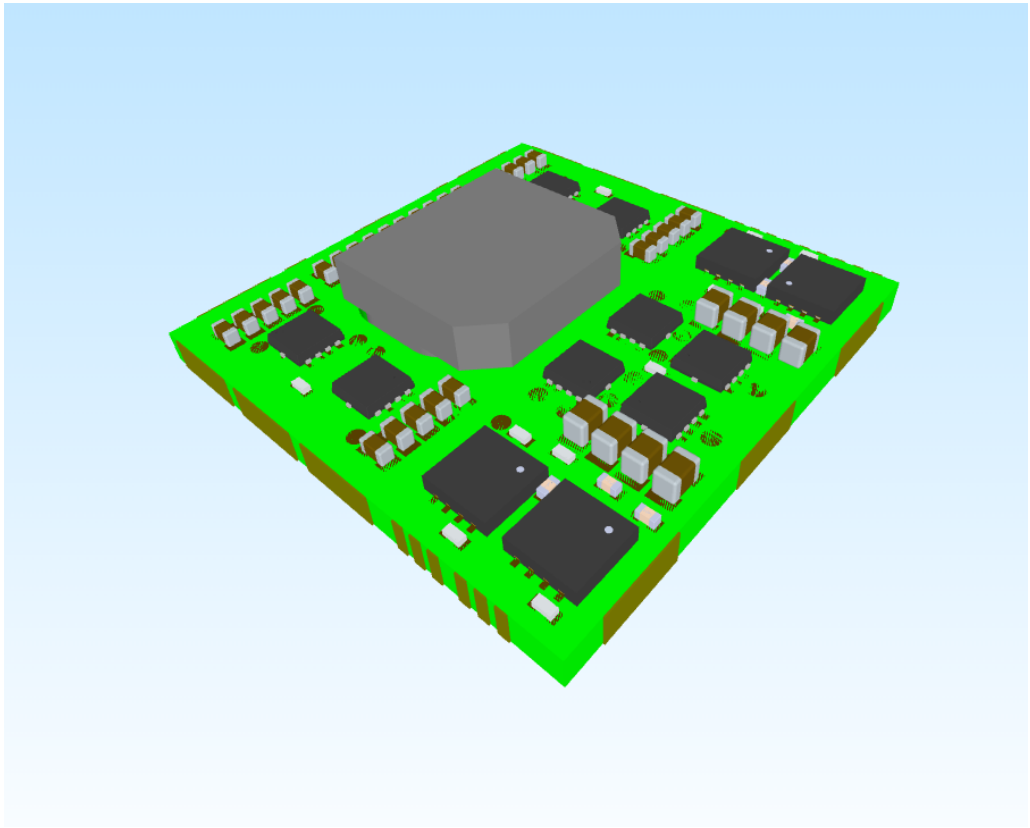
MPS LLC Power Block Module



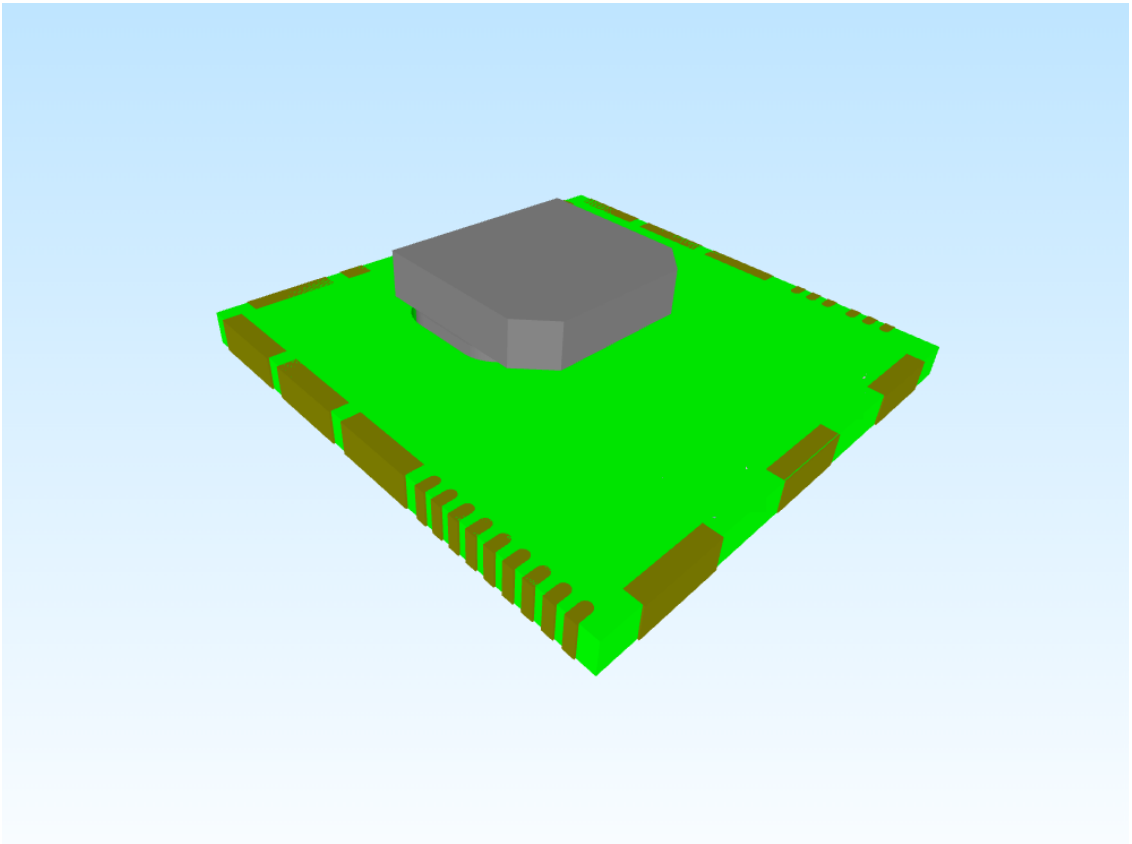


Single Block can support 500W/800W

MPS LLC Power Block Module



Top Side

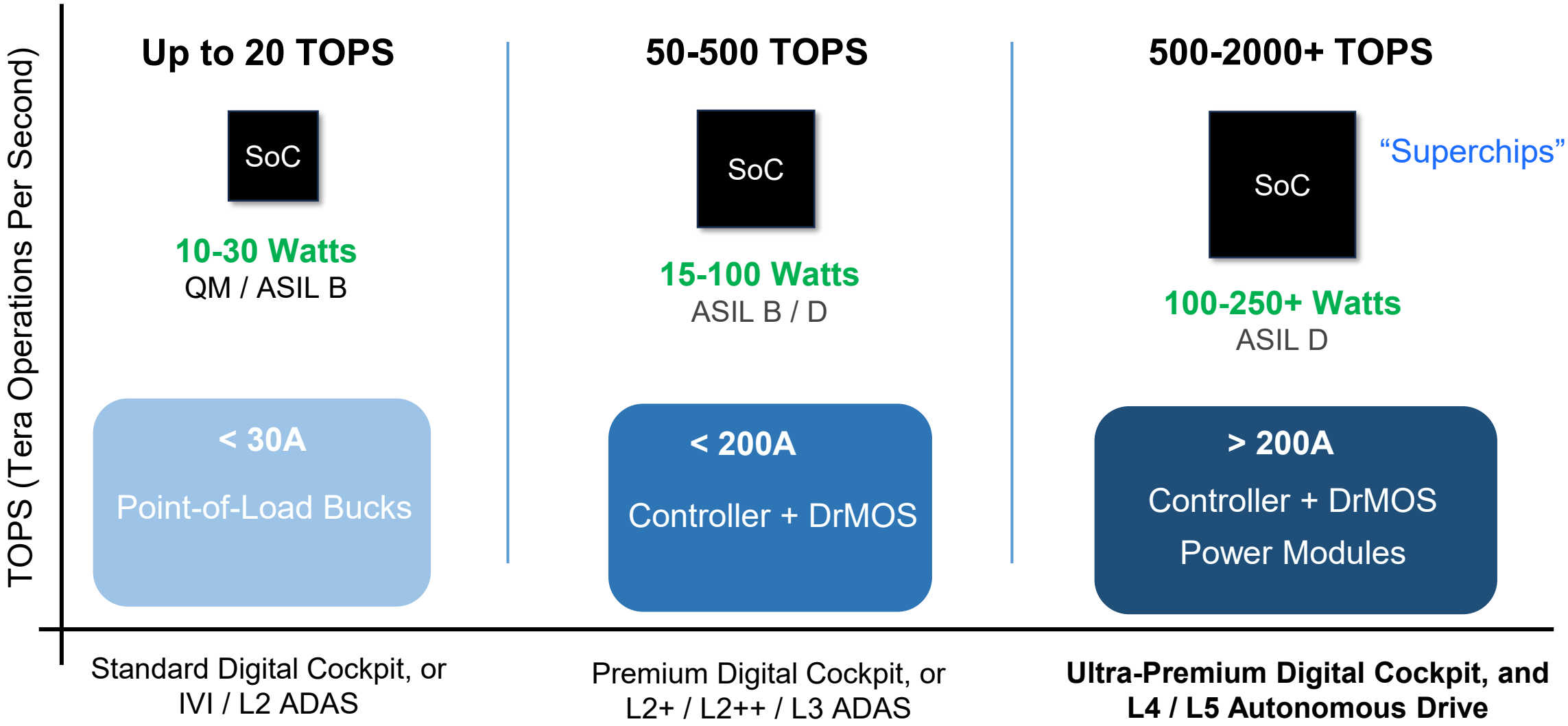


Bottom Side

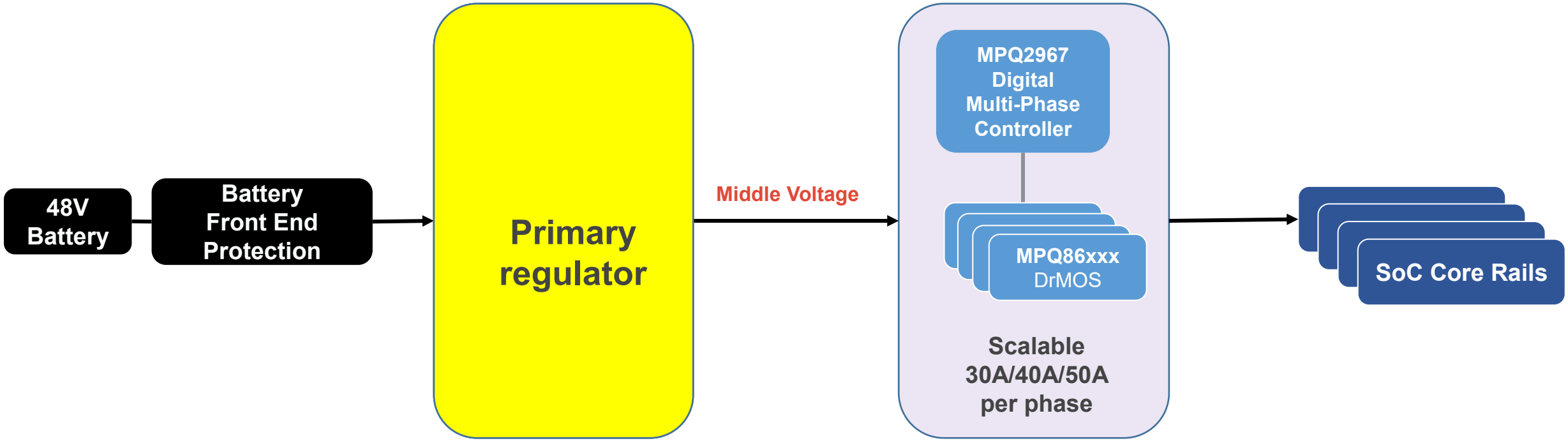
Power Block module Size is 30mm*30mm

48V of High Power SoC based ADAS/IVI

Evolution of SoC Core Power

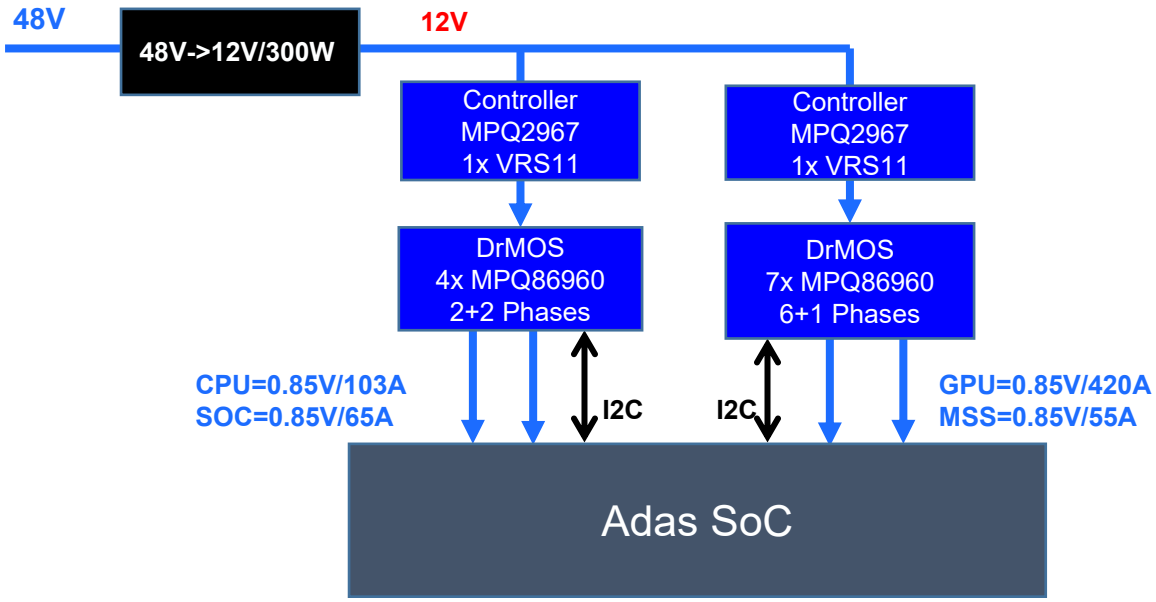


48V SoC Application

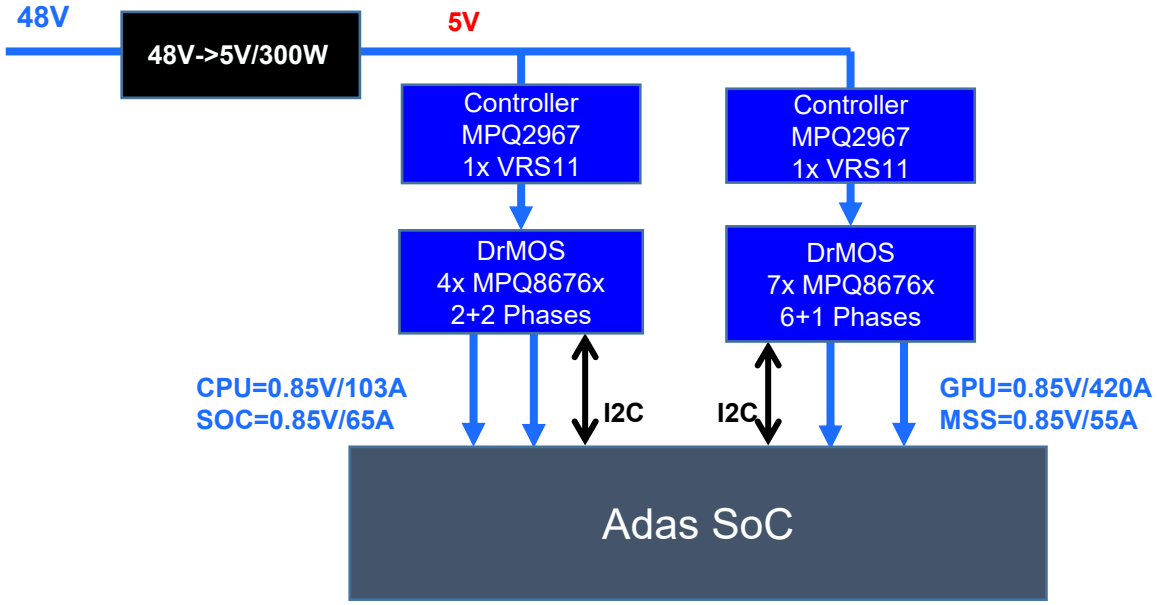


- For 48V Adas, it must use 2 stage power supply
- How to design the middle voltage and how to select primary regulator?

48V SoC Application



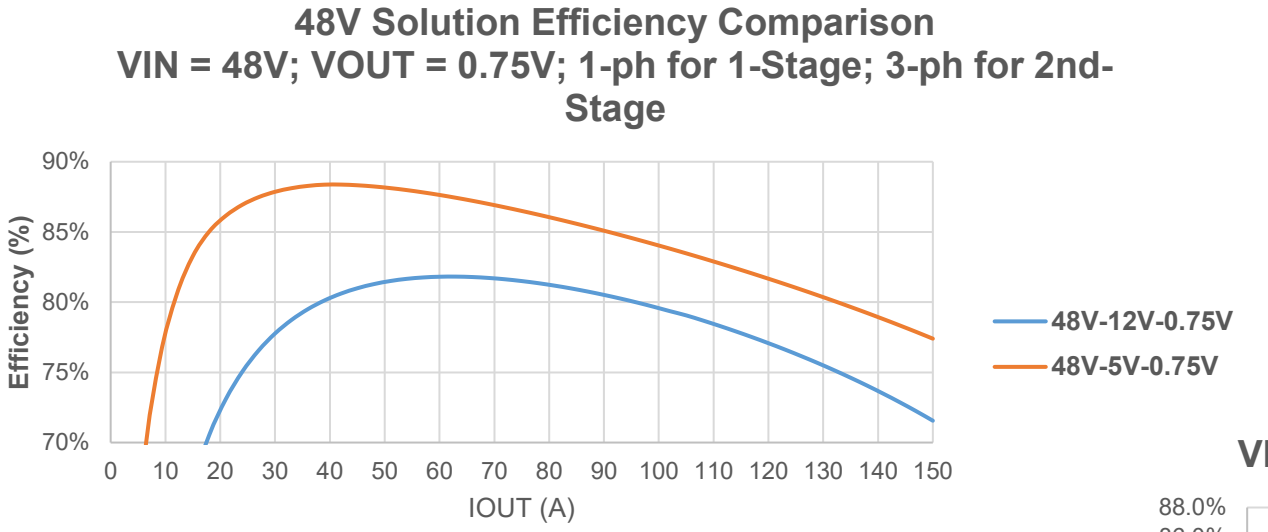
48V->12V->VR structure

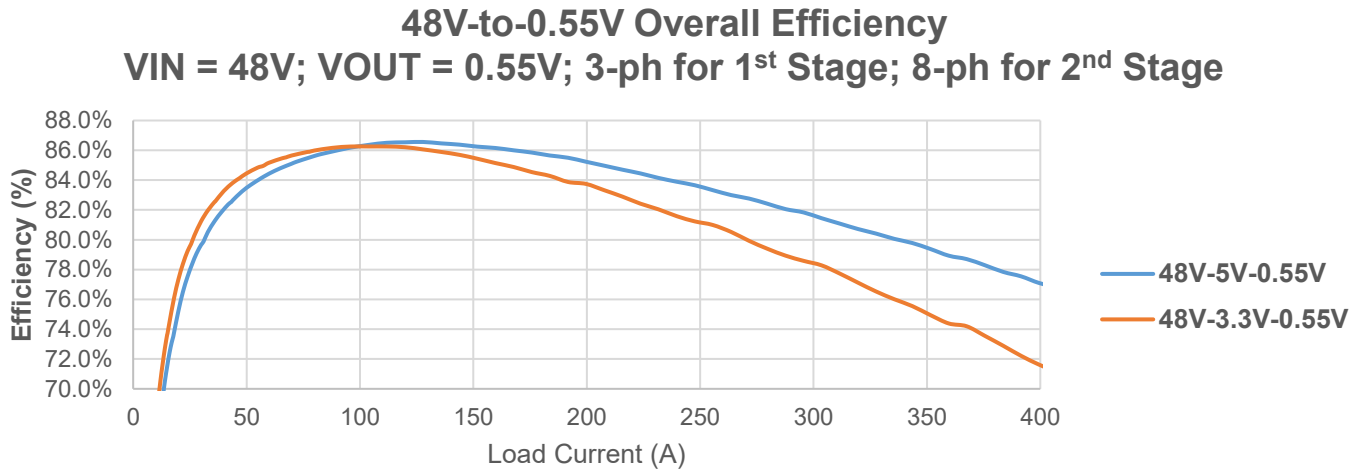


48V->5V->VR structure

MPS can provide full solution for both structure

Efficiency Comparison

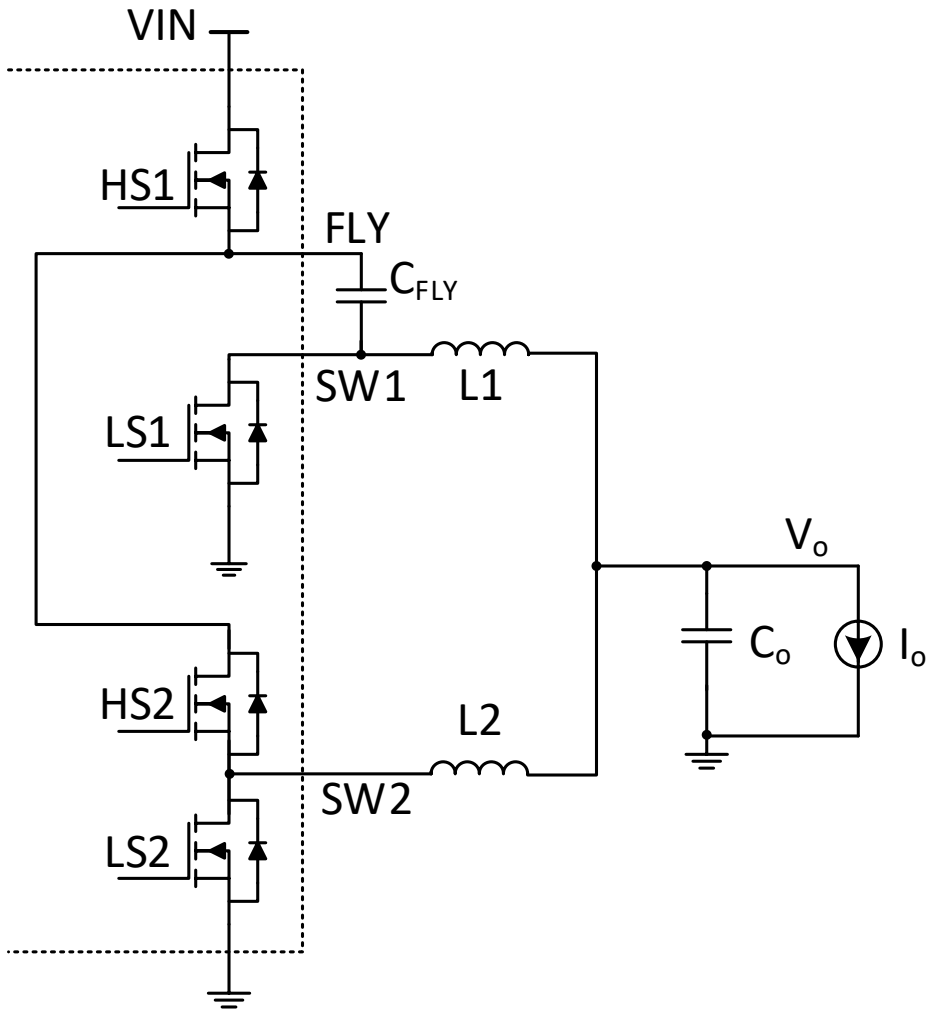




- 48V system thermal and efficiency is key factor
- 5V intermediate bus introduce the highest overall efficiency for 48V-to-core rail conversion
- If select better primary 48V regulator, 48V->5V efficiency can improve a lot

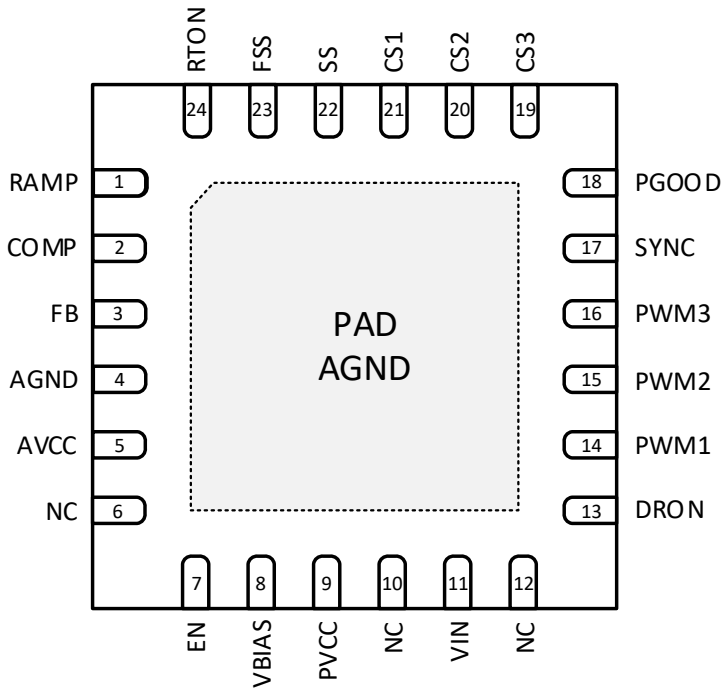
Better 48V Primary Regulator (3-level Buck)

- 4 switching devices along with 1 flying capacitor are used to form a 2-phase converter.
  - 2 HS FETs + 2 LS FETs
- ½ VIN on the flying capacitor at steady state
- ½ VIN on LS1, and LS2 → Lower voltage rated device could be used
  - **Higher efficiency**
  - **More compact design**



Better 48V Primary Regulator (3-level Buck)

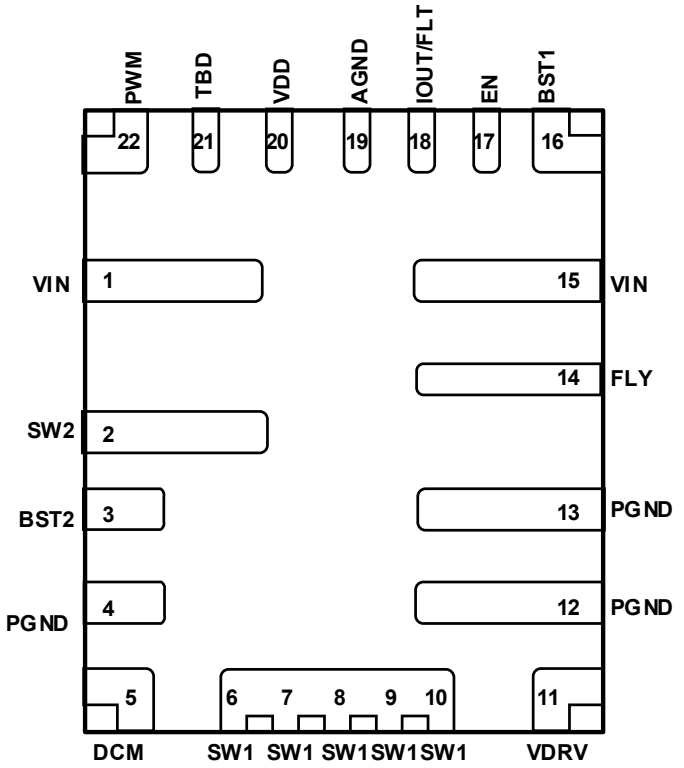
Digital Controller: MPQ2926x



QFN-24

4mm × 4mm with 0.5mm pitch

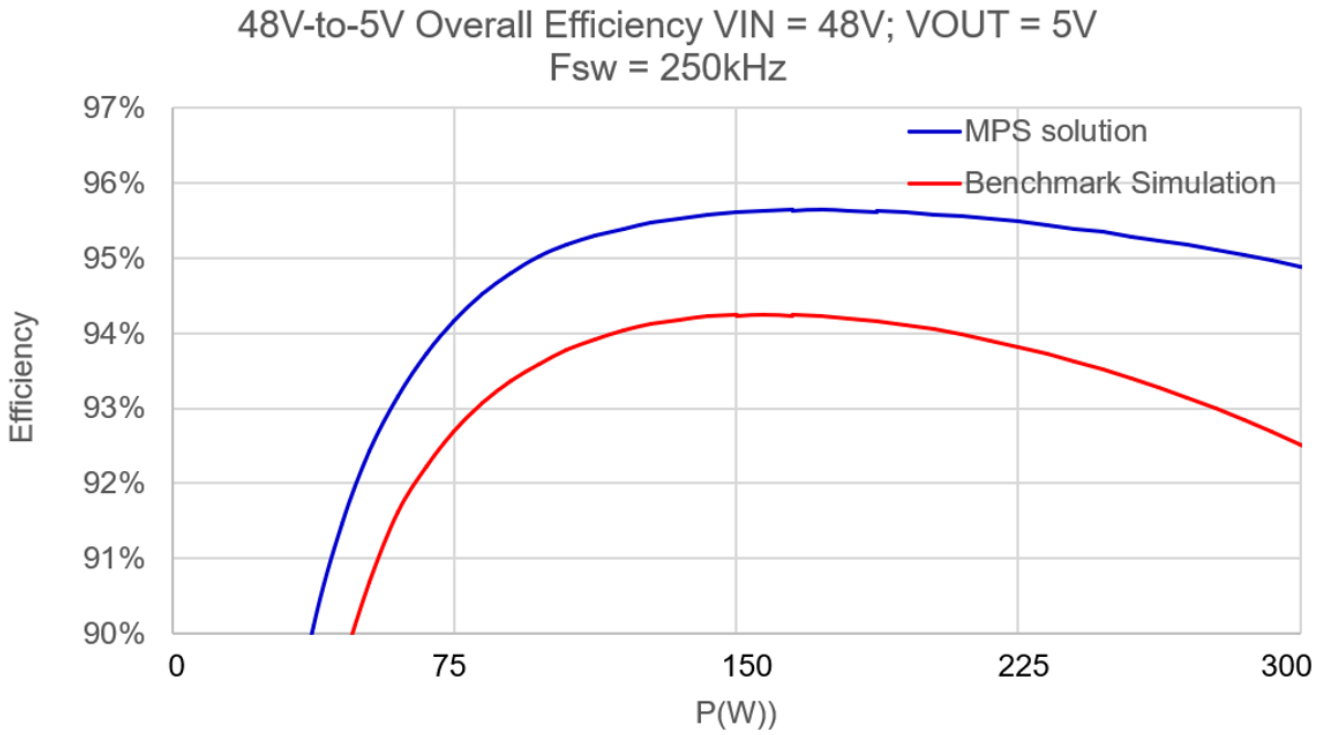
Intelli-phase™ 65V DrMOS: MPQ867xx



QFN-22

5mm × 6mm with 0.5mm pitch

Efficiency Comparison (VOUT = 5V)



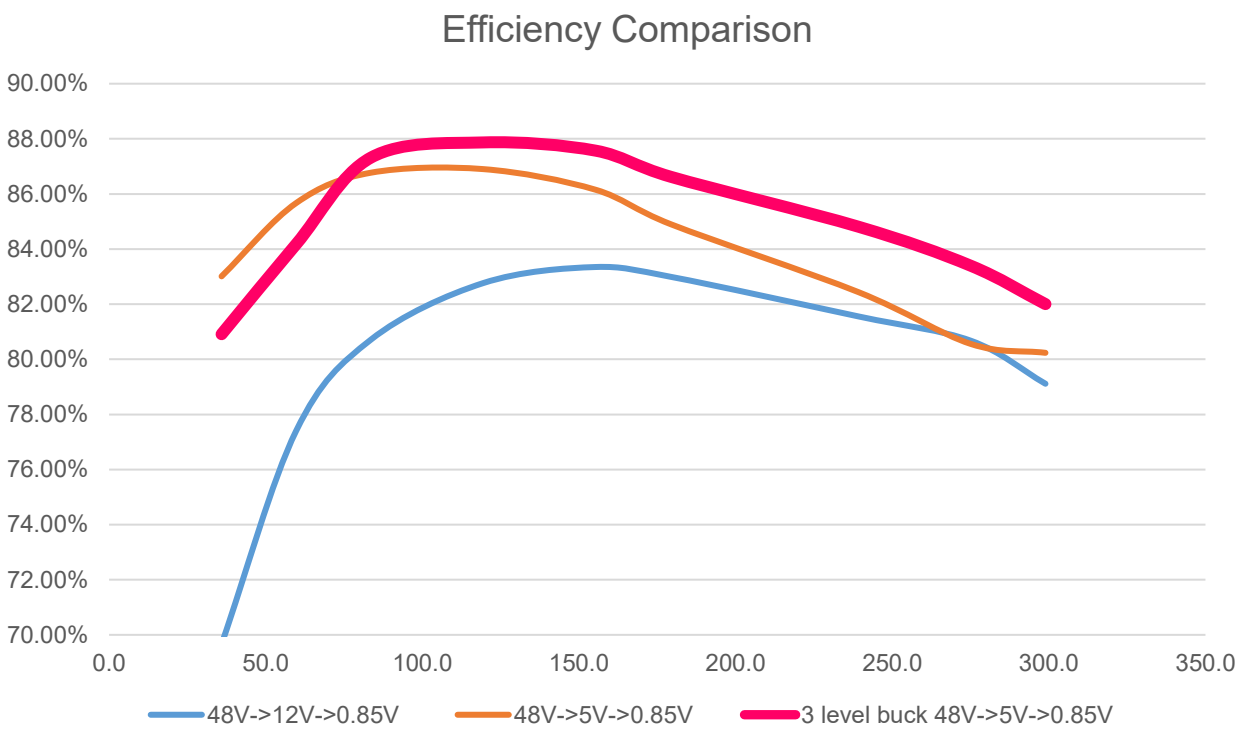
- 3 phase buck
  - HSFET: 32 mΩ
  - LSFET: 4.5 mΩ
  - Inductor: VCUD128T-2R5MS8

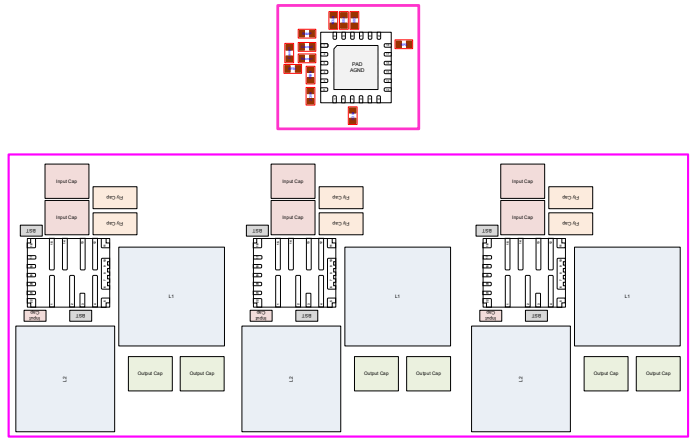
- MPS 48-5V 3-Level Converter
  - MPQ29xxxx
  - MPQ86xxxx

3-level converter realizes higher efficiency than multiphase buck solution

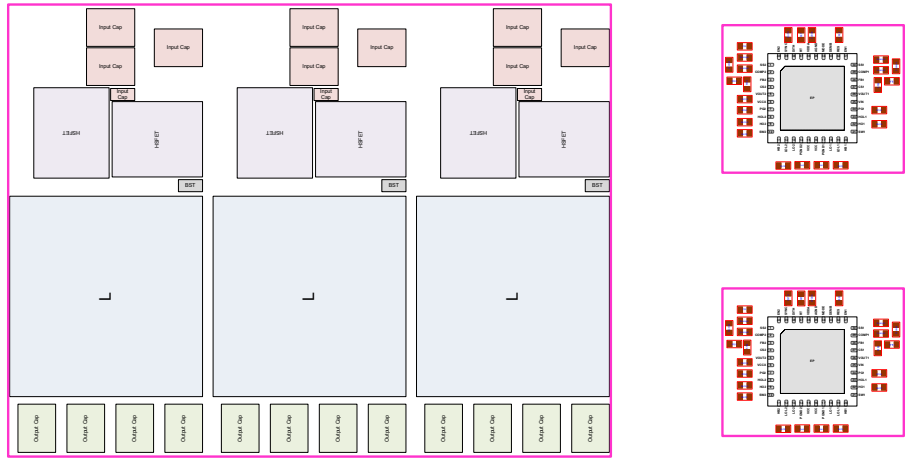
- >1.5% higher for peak efficiency
- >2% higher at heavy load

3 level buck 48V->5V-VR Solution





MPS Solution:
50mm × 21mm + 8mm × 7.5mm = 1110mm²



Benchmark Solution:
40mm × 30mm + 12mm × 10mm × 2 = 1440mm²

MPS 3-level topology realizes more compact design:
- **50% output capacitor reduction**
- **23% PCB layout area reduction**

Thanks