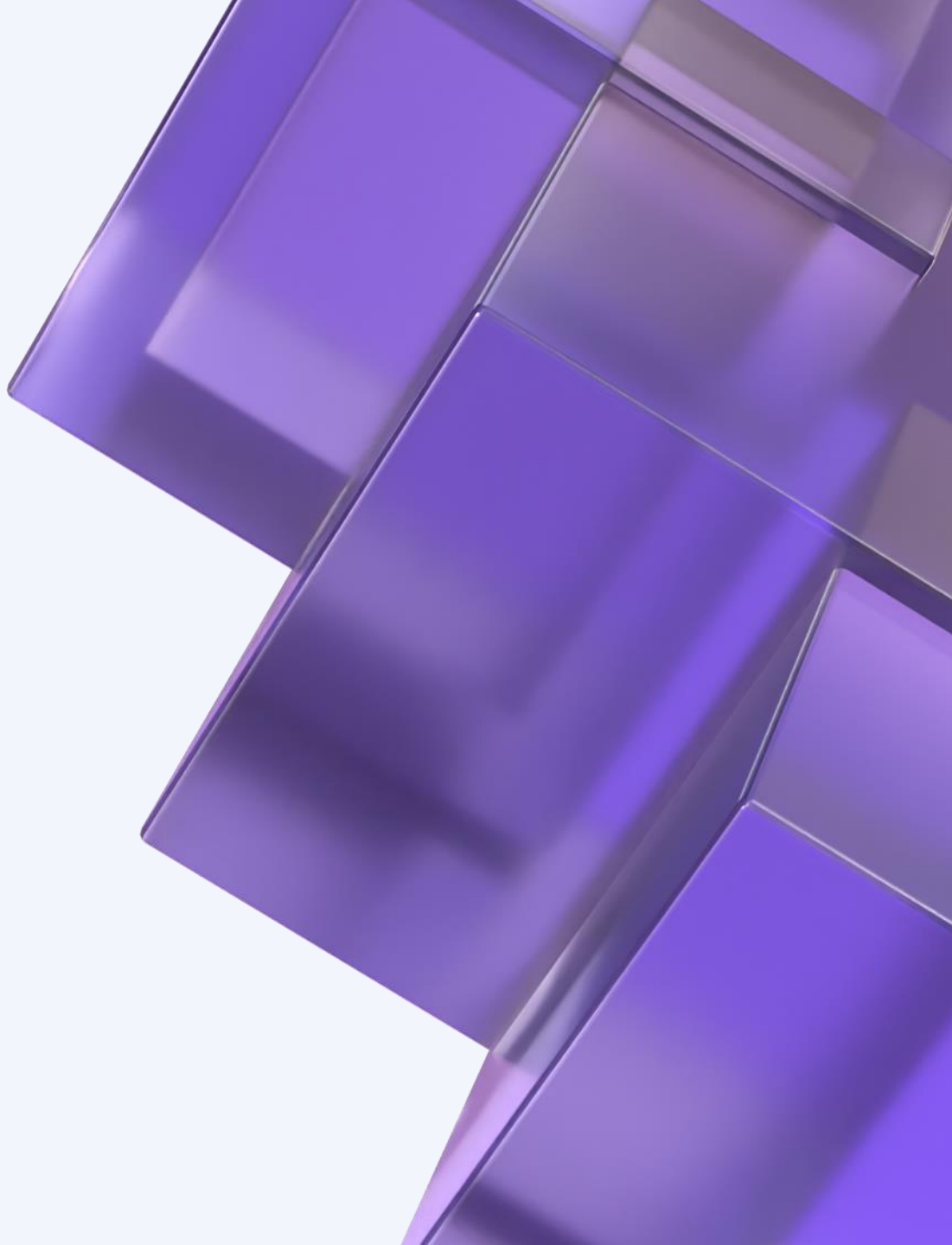
Intelligent Power Solutions for Next Generation Robotics Platforms

Jason Yin, Lilly Zhong

Nov 2026



Agenda

- Introduction to AI Robotics – Market Growth & Major Drivers of AI adoption in Robotics
- Brief Overview of the Robotics SoC Platform
- Challenges in Powering the High Performance Compute SoCs in Robotics
- MPS‘ Key Technology Differentiators to solve the Challenges
- Controller + DrMOS + PoL solutions for Intelligent Power Management
- Conclusion

Robotics Market Growth

Automotive × Robotics



ADAS ZCU



Camera Modules



LiDAR



Brain Modules





Mic and Speaker



Joint Motors



Screen





Battery

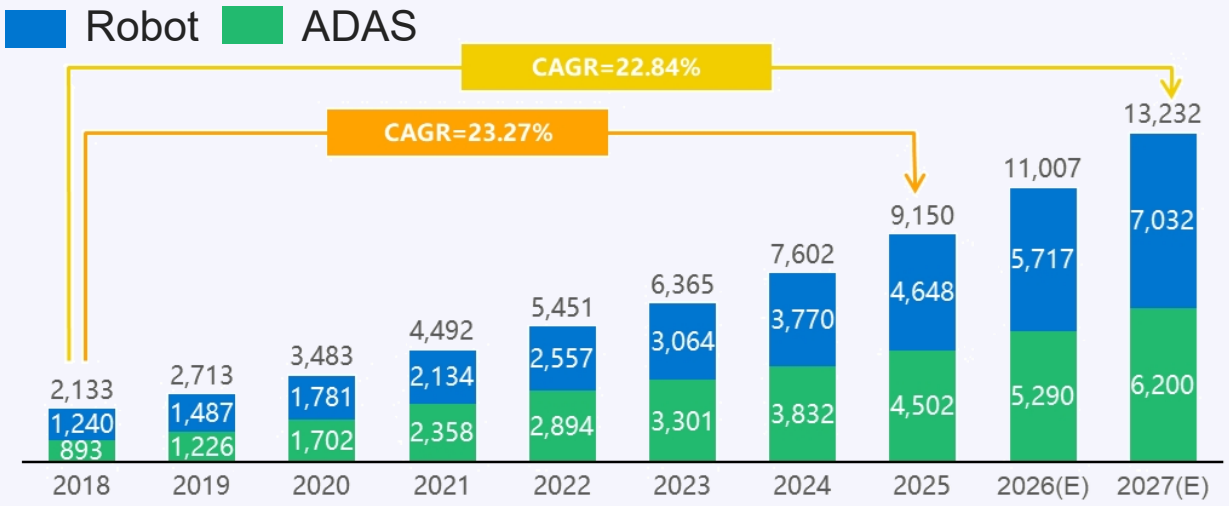


Battery

- Robot structure is designed like vehicle.
- Now, auto is one type of robots.

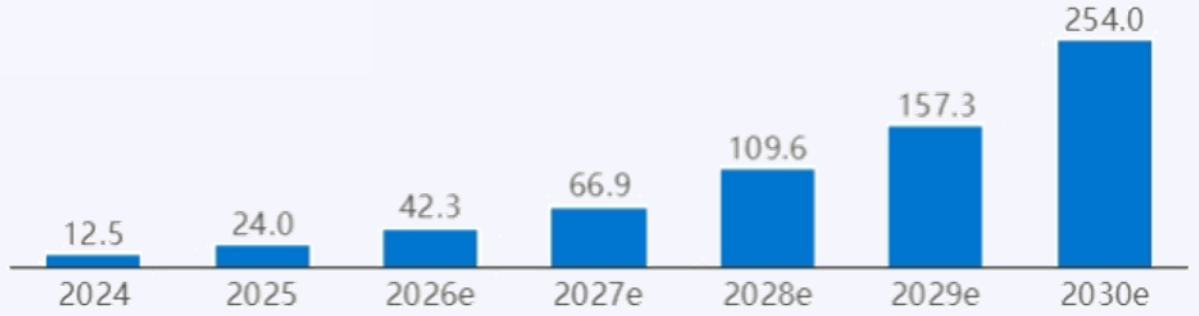
Robotics Market Growth – Key Economic Drivers

China Embodied AI Market Scale Estimation (Unit: ¥100M)



Source: 36Kr

China Humanoid Robot Market Estimation (Unit: ¥100M)



Source: CGII, ChnCi, 36Kr

- Humanoid Robotics Market is set to reach ~¥25B by 2030
- Increasing demand for industrial automation across manufacturing sectors



Robotics Market Growth – Key Application Demands

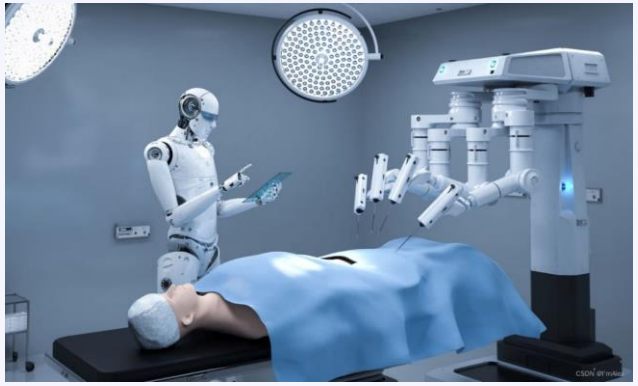
- Technological advancements enabling more capable and affordable robots
- Growing adoption in non-traditional sectors



Patrol



Firefighting



Healthcare



Retail



Logistics

Robotics Market Growth – Key Technological Drivers

AI / Edge Compute
- Vision , perception, decison making on-device

Advanced Sensors
- Cameras, radar, LiDAR, tactile sensing

Electrification
- Battery powered operation (mobility, efficiency)

Connectivity
- 5G / Industrial networks enabling coordination

High Perfrormance Compute SoCs
- GPU/AI accelerators driving the compute demand

Miniaturization
- More capabilities in smaller form factors

Convergence of AI + Sensing + Compute + Power Efficiency



MPS Solutions for Robotics

MPS has end-to-end solutions to cater to the Power Management Requirements in Robotics Solutions



Rotary joint motor



Linear joint motor



Coreless motor



BLDC motor

Actuators

- Motors
- MCUs
- Motor Drivers
- Servo Controllers
- Angular Sensors
- Power Modules

Drivers

- Isolated gate Drivers
- Isolated DCDC supplies
- Digital Isolators
- Current Sensors
- GaN HEMTs



Compute

- Multi-phase Controllers
- Intelli-phase DrMOS
- PoL Regulators
- Intelli Modules
- (FuSa) PMICs





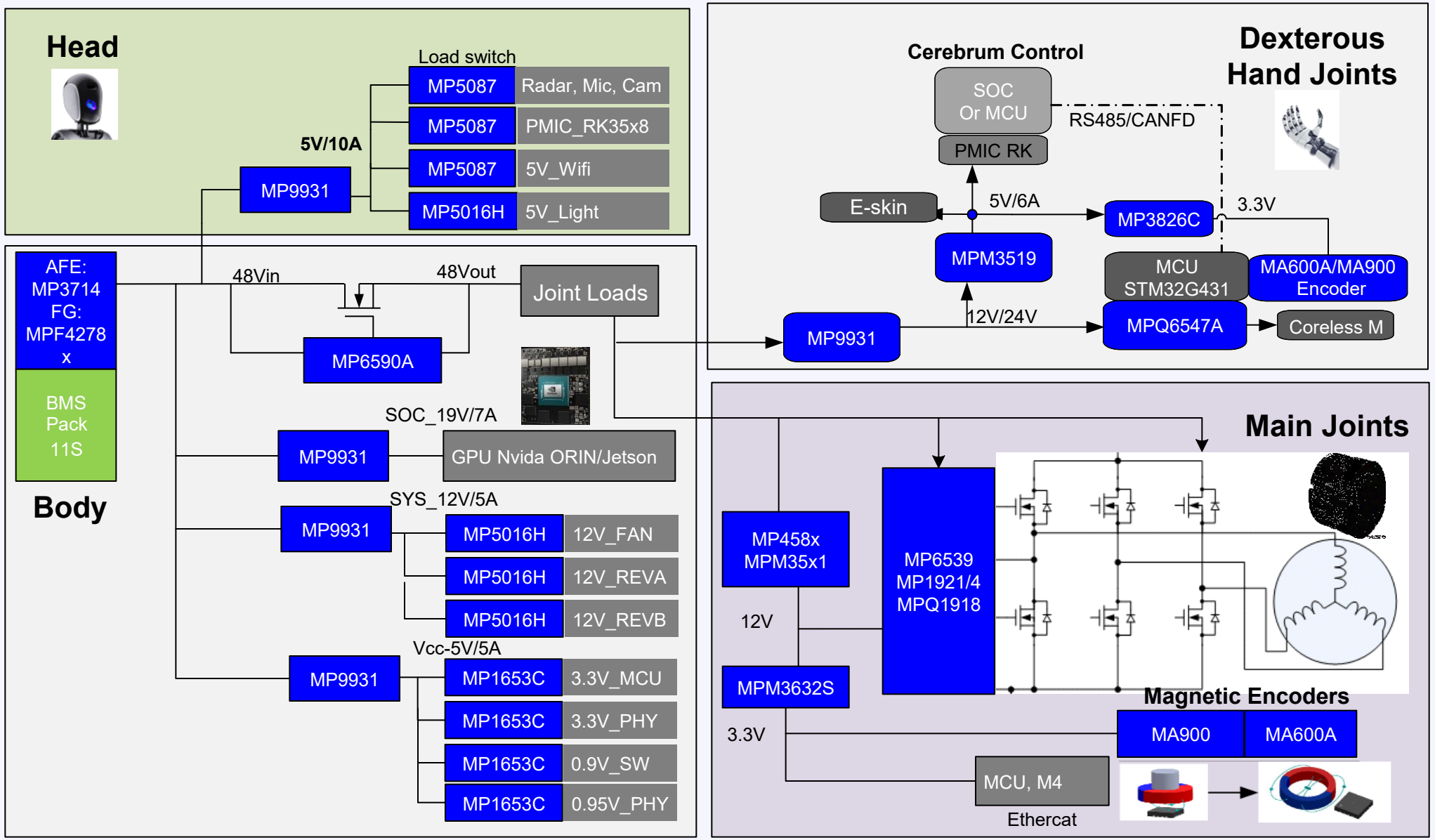
Battery Management

- Protection Drivers
- Battery Monitors
- Fuel Guage
- Active Balancers
- Load switches





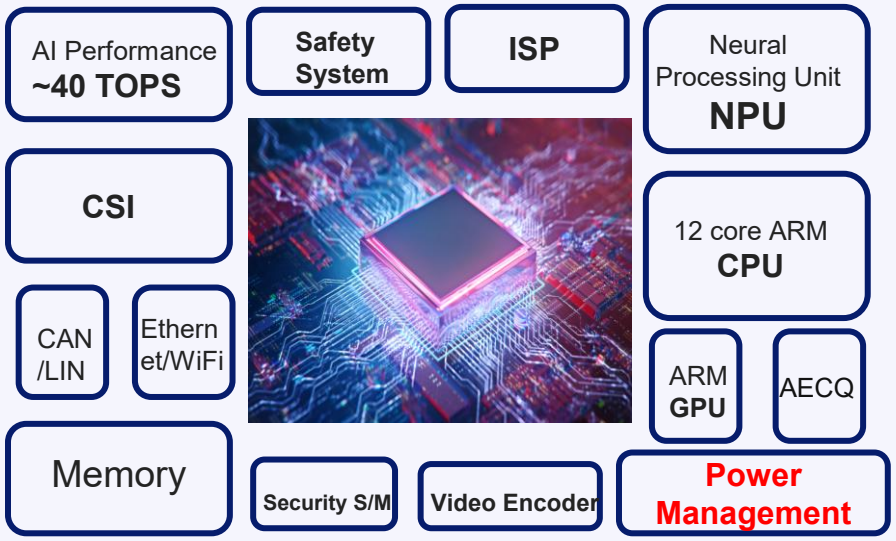
MPS General Hardware Solutions for Humanoid Robot



Robotics SoC Platforms

Why should we focus on the SoC Platform?

SoC Platforms are becoming Compute Intensive and Power Hungry!



These Platforms form the brain of the Robotics System Architecture and efficient Power Management is Critical!

Global Partnerships for Robotics

MPS powered multiple generations of SoCs for global SoC suppliers



Horizon Robotics

mobileye™



Qualcomm

AMD



momenta

socionext
The Solution SoC Company

BLACK SESAME TECHNOLOGIES

HUAWEI

Telechips

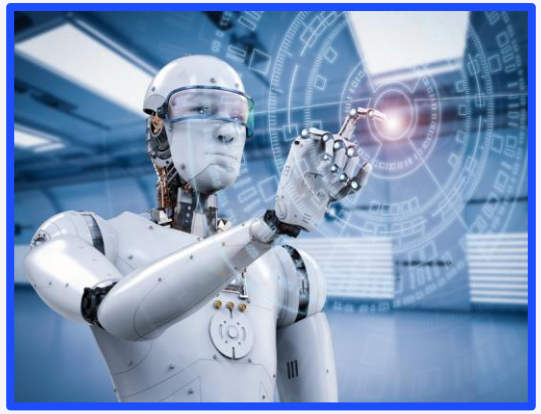
MEDIATEK

siengine
芯 擎 科 技

Ambarella®
AI envisioned™

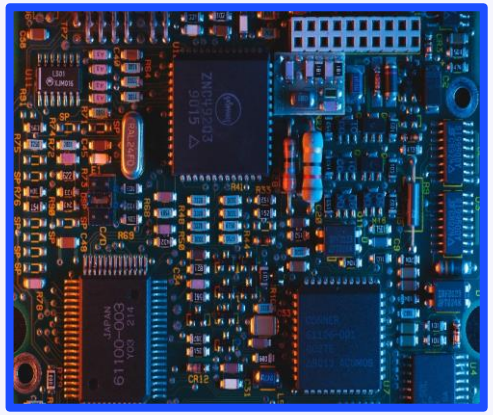
Challenges in Powering the Robotics SoCs

Battery Dominated Systems



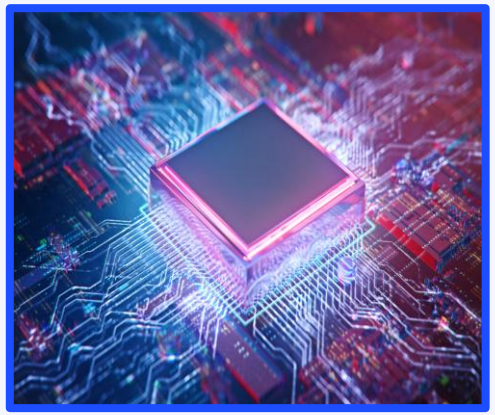
- Limited Energy Budget and need for longer run time
- **Requirement** :Sleep mode , Low Iq, Phase shedding techniques to extend operating times and convserve energy

Smaller Form Factors



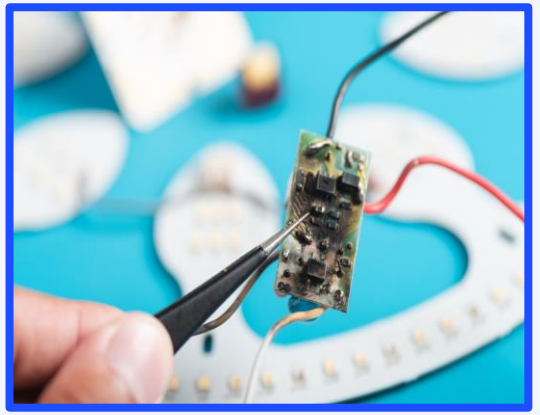
- Systems shrink -> but batteries remain bulky and more power needs to be delivered
- **Requirement** : Advanced Packaging and Integration technologies

Dynamic Workloads



- AI SoCs switch rapidly between workloads
- **Requirement** : VRs that can respond immediately to sudden current spikes – fast transient response

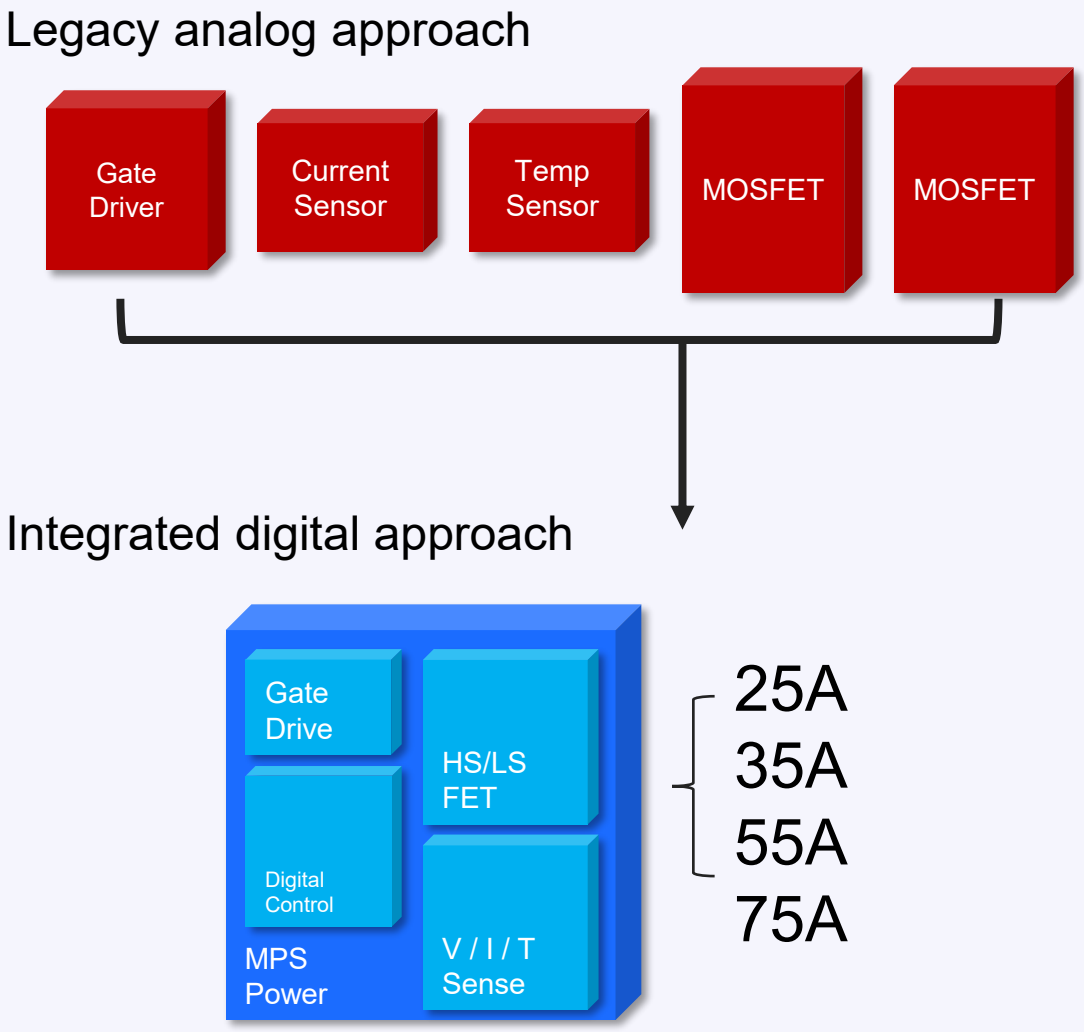
Thermal Management



- No heatsinks or fans
- Limited airflow in the head/torso
- **Requirement** : deliver high currents with minimal losses without overheating the system

Advanced Integration Technology for Smaller Form Factors

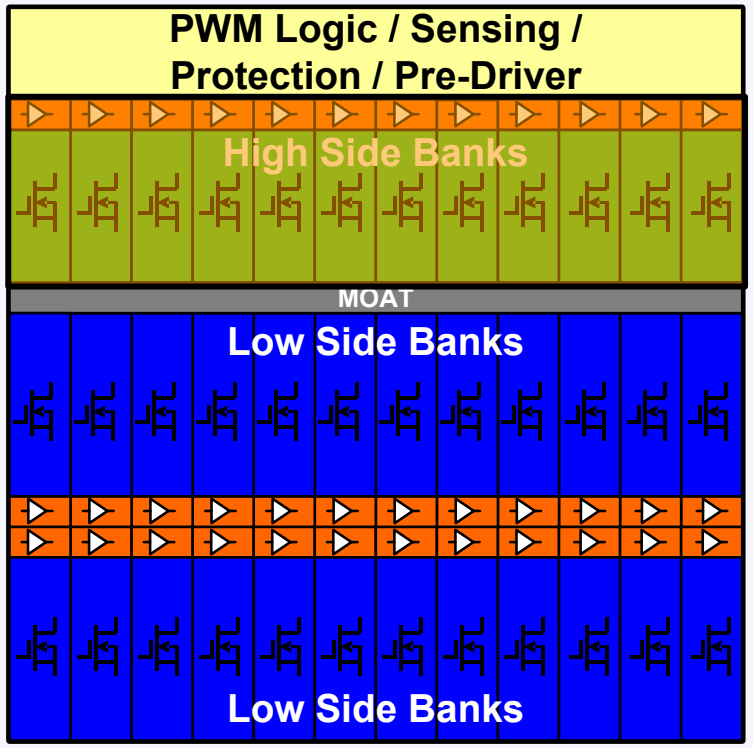
SoC Power Management Needs High Integration



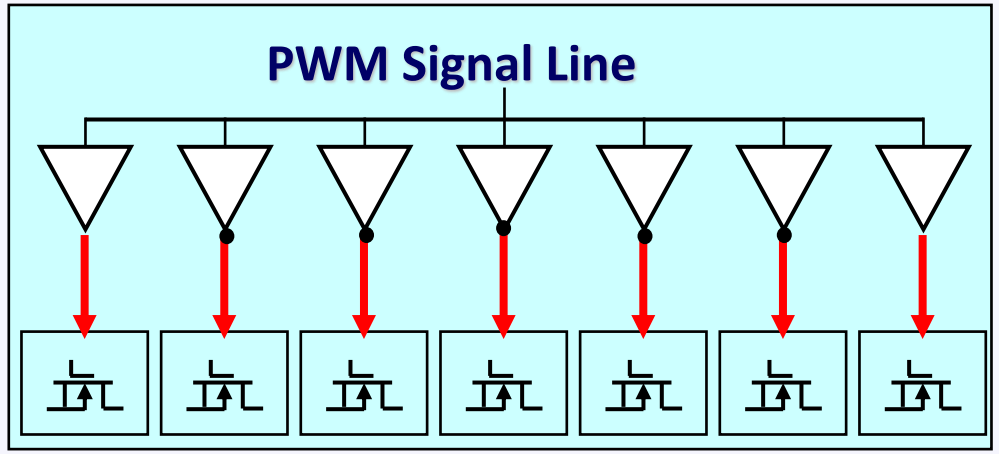
Integration Unlocks Massive Benefits

- ✓ High Power Density
- ✓ High Efficiency
- ✓ High Reliability
- ✓ Accurate Current Sensing
- ✓ Accurate Temperature Sensing

MPS Proprietary Monolithic DrMOS Design



Distributed Gate Driver (DGD) minimizes the gate delay, therefore ensures even current distribution among cells

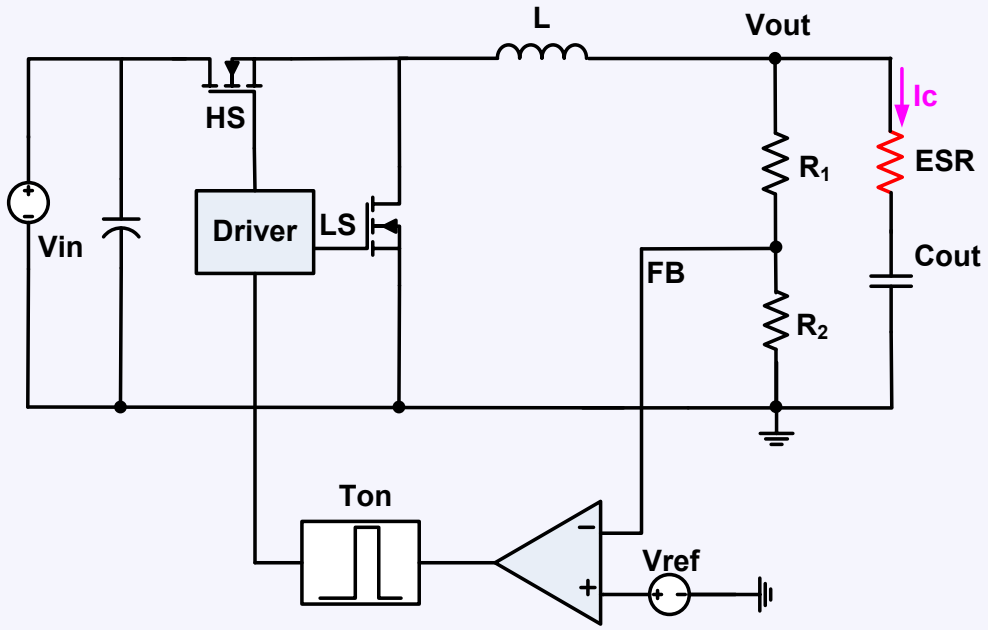


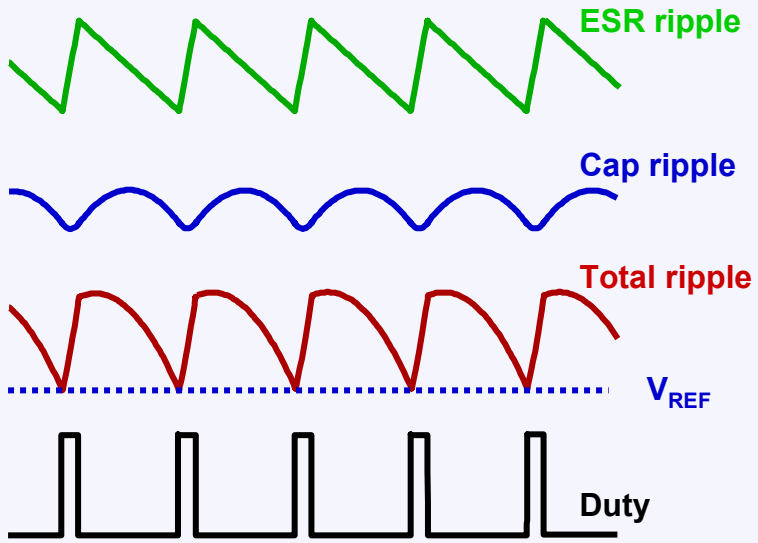
Integrates drivers, FETs, PWM logic, sensing and protection circuits into **one piece of silicon** and operates seamlessly.

Monolithic DrMOS enables compact, efficient, fast power delivery with improved reliability making it ideal for high performance and space constrained robotics platforms

Advanced PWM Technique for Dynamic Workloads

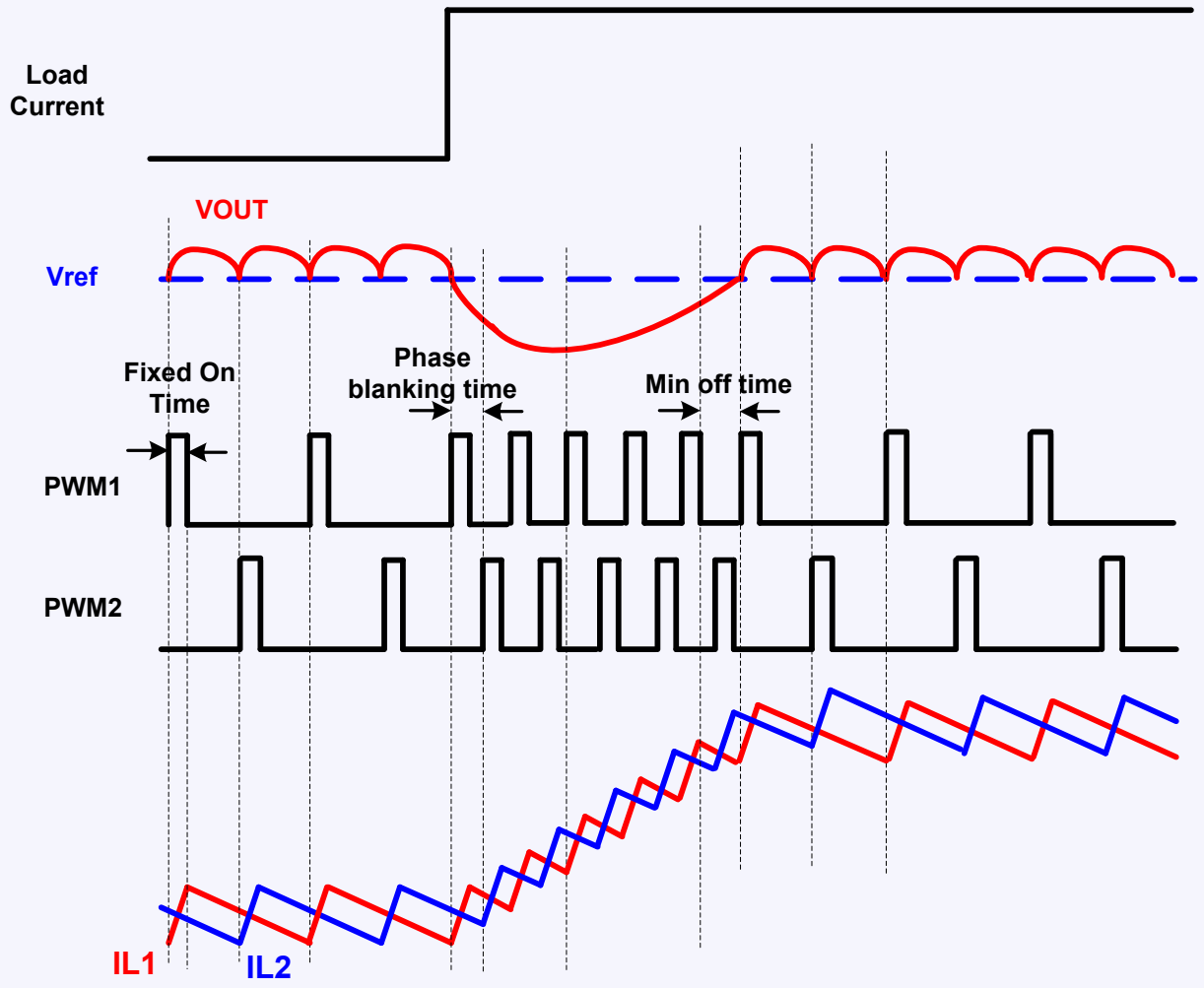
MPS Advanced COT PWM (ACP™) Control





- V_{OUT} ripple is directly compared with V_{REF} to determine PWM turn-on.
- Variable frequency operation
- On-Time pulse width is fixed.

Advanced COT Improves Dynamic Current Sharing



Reducing PWM off time to support transient load, while PWM on time keeps constant.

PWMs are evenly distributed to each phase.

The inductor current of each phase increases as the pattern of “multiple quick small steps”.

- **Inherently much better dynamic current sharing than voltage or current mode control.**

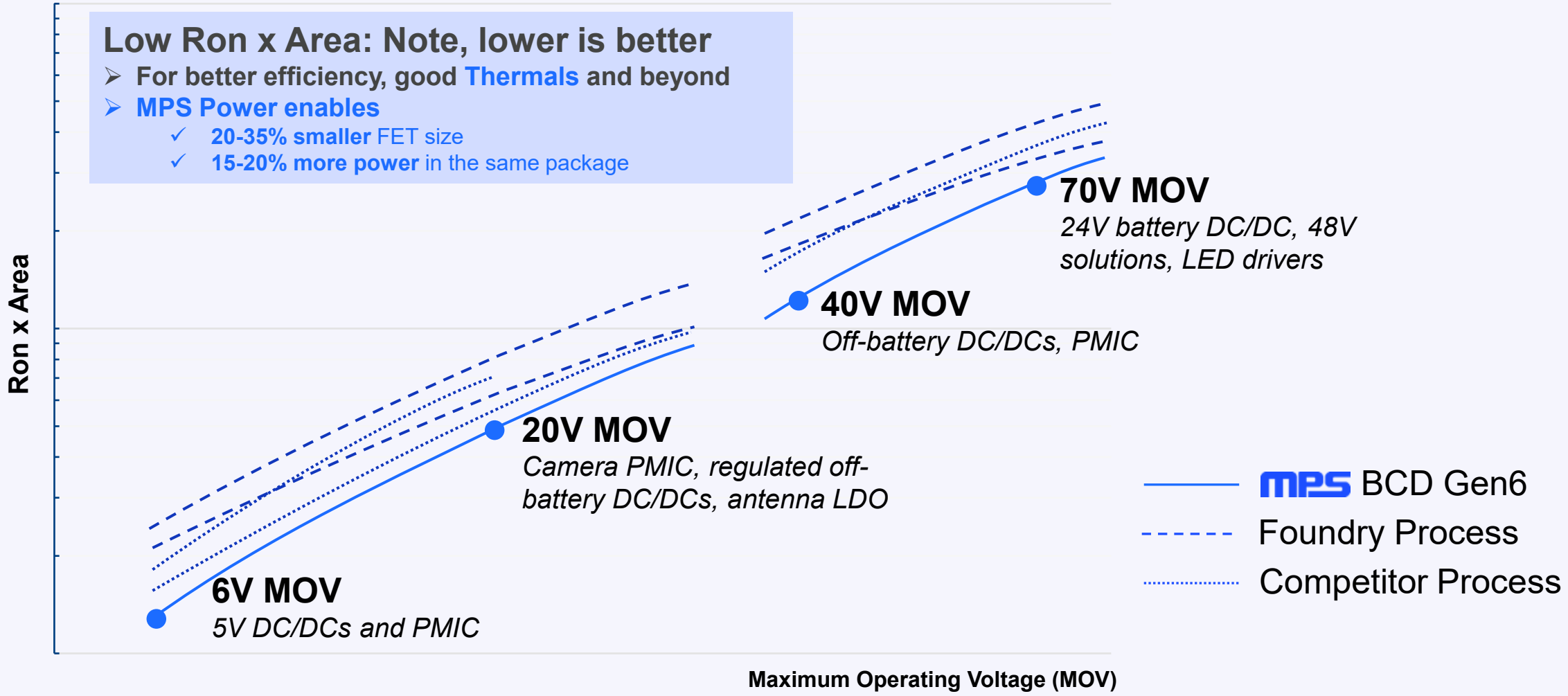
Power Management Scheme to Extend Battery Life

Power Management IC Features

- Low Quiescent Current
  - Lowers the system's current consumption at Idle or Sleep state
- Configurable Mode of Operation
  - Discontinuous Conduction Mode **(DCM)** operation at light load condition leads to lower switching frequency --> significantly decreases the switching losses of the converter
  - Continuous Conduction Mode **(CCM)** operation lowers the RMS current flowing to the converter --> lessen the conduction losses
- Supports Adaptive (AVS) and Dynamic Voltage Scaling (DVS)
  - **AVS:** The IC's ability to follow the voltage setting required by each chip due to process variation
  - **DVS:** Adjusting the converter's output voltage on the fly to adopt to the SoC or FPGA demand
- Phase Adding and Shedding Scheme
  - Automatically adopt the number of phases depending on the output current

Process and Package Technologies for Efficient Thermal Management

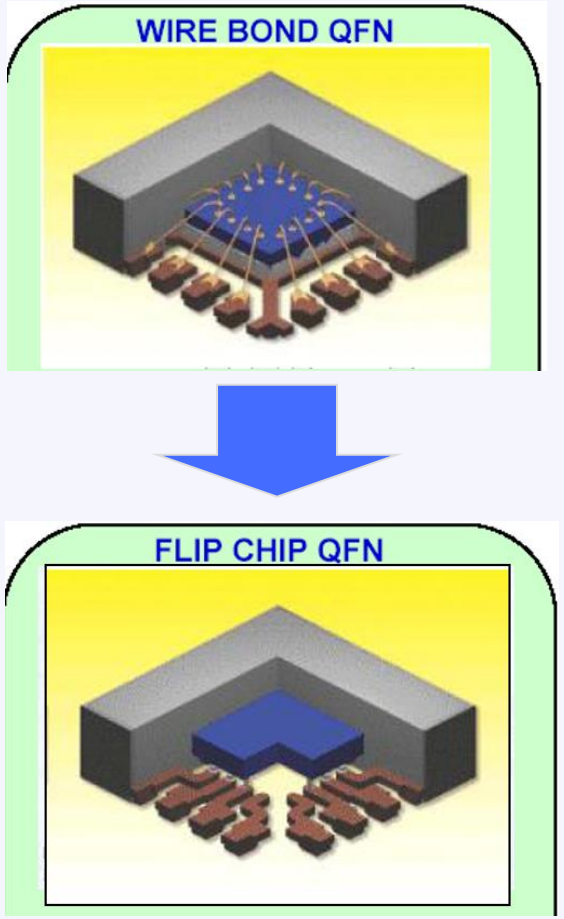
Why MPS Power : High Power Density Process



Approximations shown only

4. Flip Chip Packaging Technology

1. **Reduced Thermal Resistance (RθJA)**
   - Advanced packages significantly lower junction-to-ambient thermal resistance, enabling higher power dissipation without oveheating
2. **Improved Electrical Performance**
   - Elimination of wire bonds gives rise to Lower parasitic inductance and better conduction paths
3. **Enhanced heat flow**
   - Close placement of die, caps and copper paths improves thermal spreading and switching efficiency
4. **Enables higher power delivery in compact robotic systems**
   - Supports higher power output in small footprints



Advanced Packaging Technologies reduce thermal resistance and parasitics , enabling higher power density and reliable operation in compact robotics platforms

MPS High Current Core Power Solutions

Controller + DrMOS + PoLs

Digital Controller + DrMOS = Efficient & Compact Solution

Digital Control

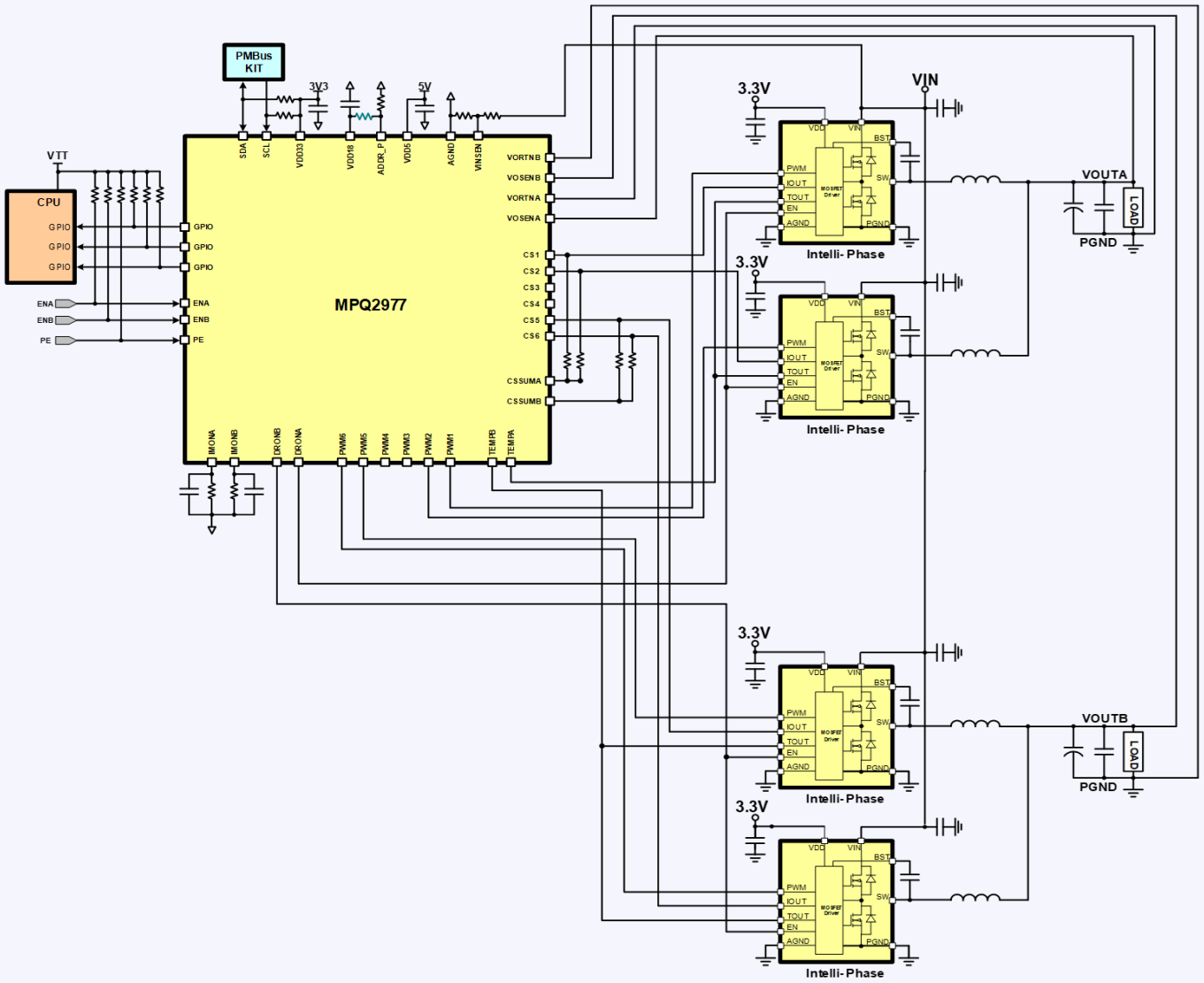
- Easy compensation
- Fast transient response
- Better current balancing
- Programmability and flexibility
- Real-time monitoring and reporting
- Comprehensive protection

Monolithic DrMOS

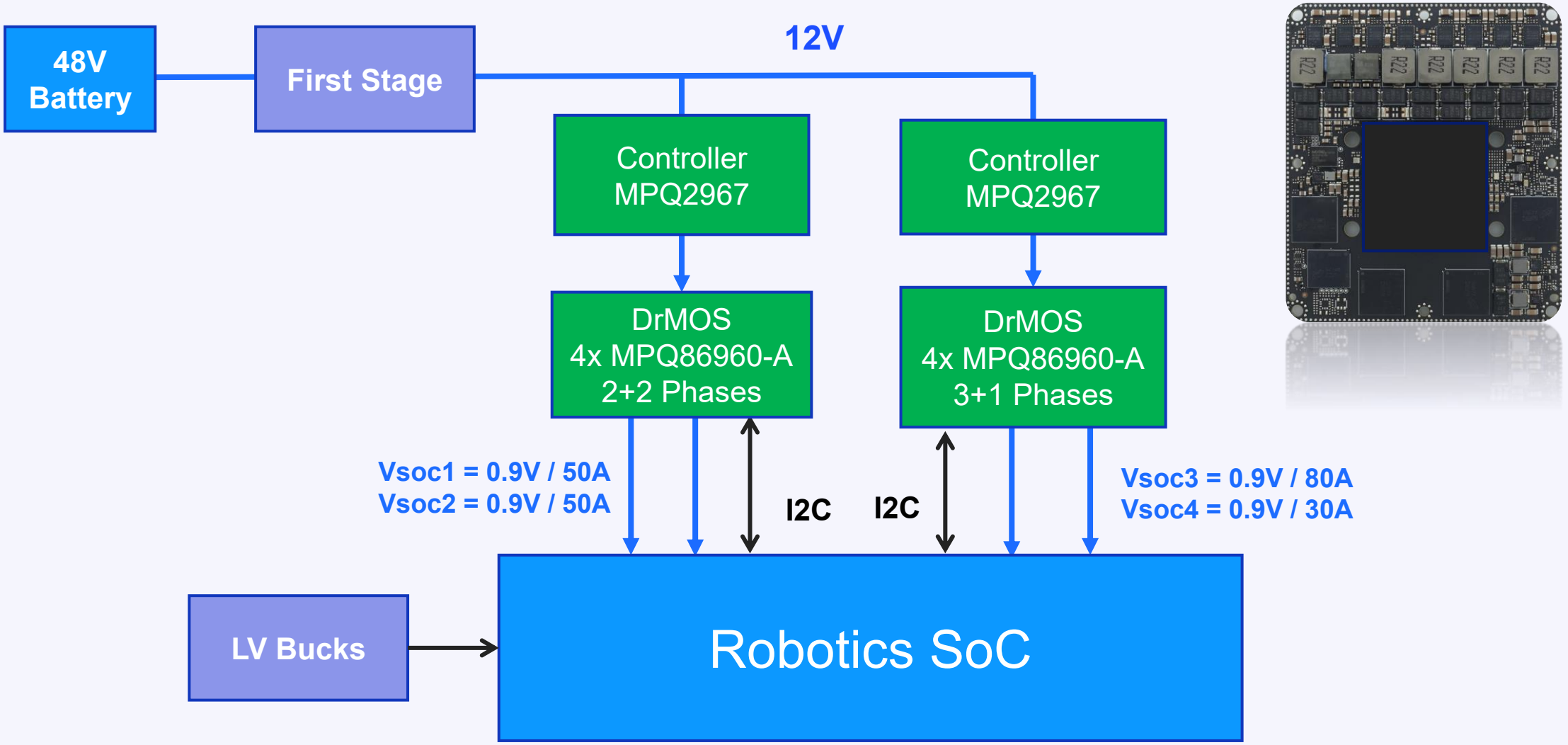
- Monolithic design – less components, more robust
- Switching loss reduction – higher efficiency
- Superior current sensing accuracy

Fewer External Components

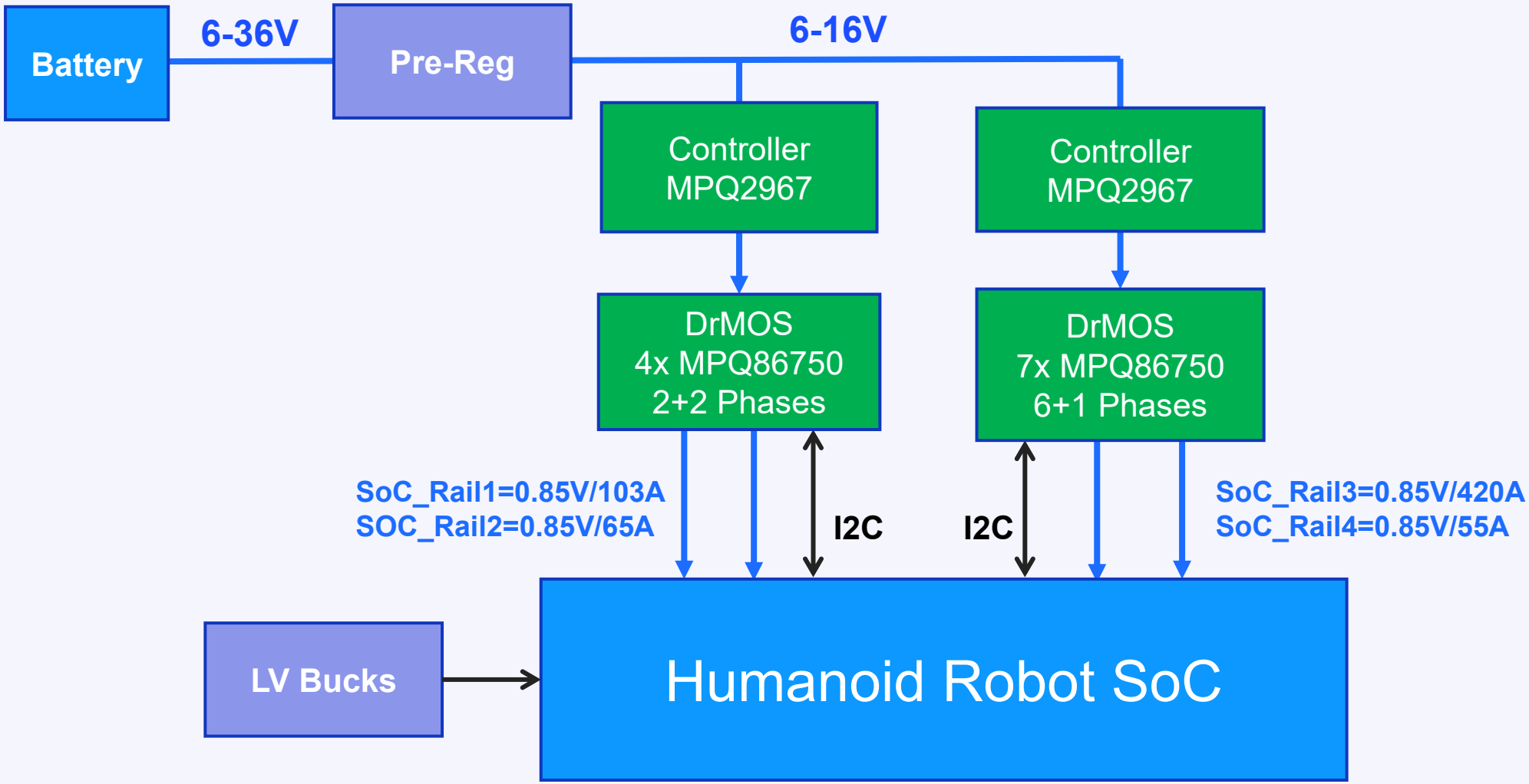
- Lower cost
- More compact design



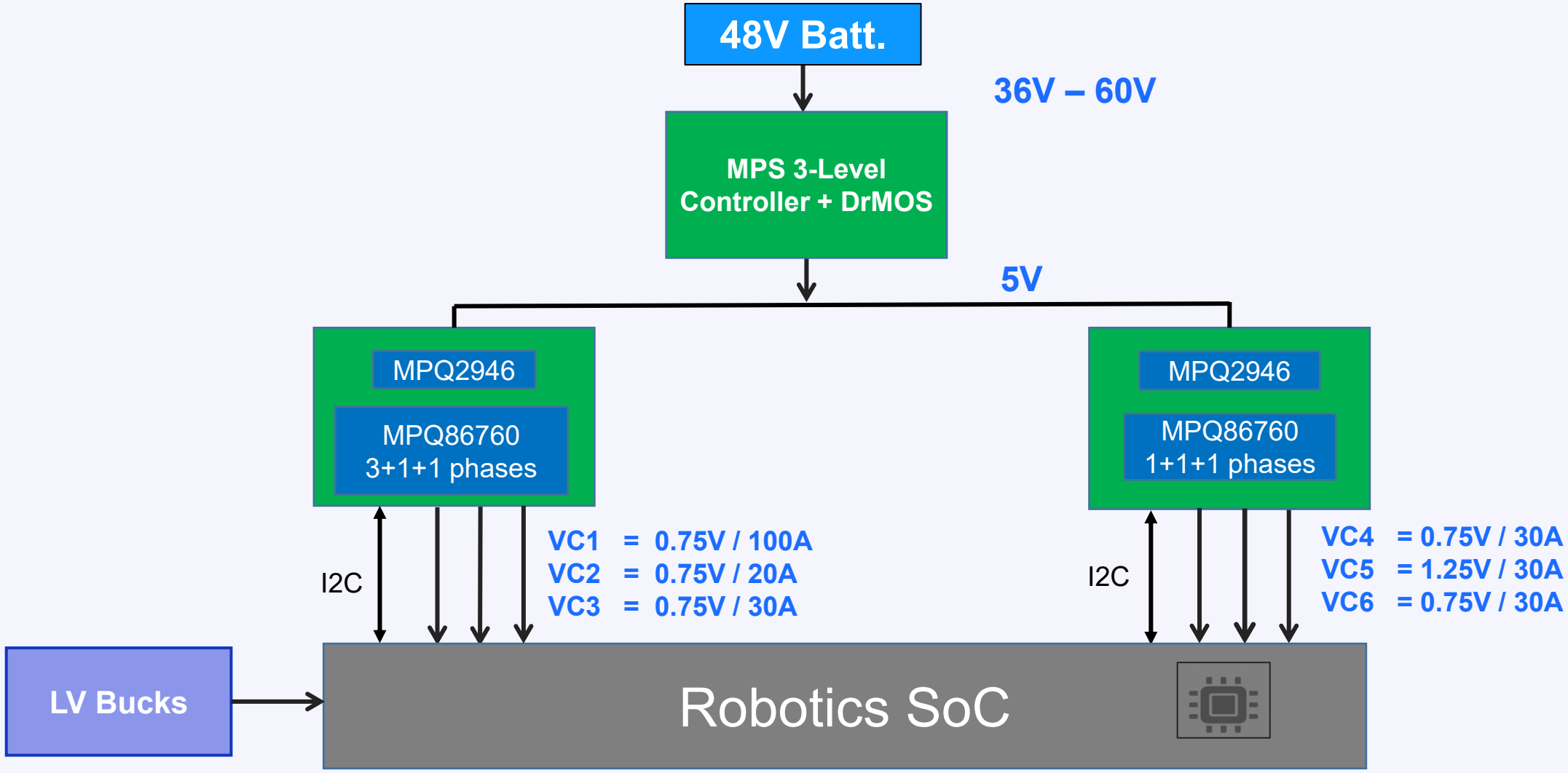
An Example for Robotics SoC Core Power



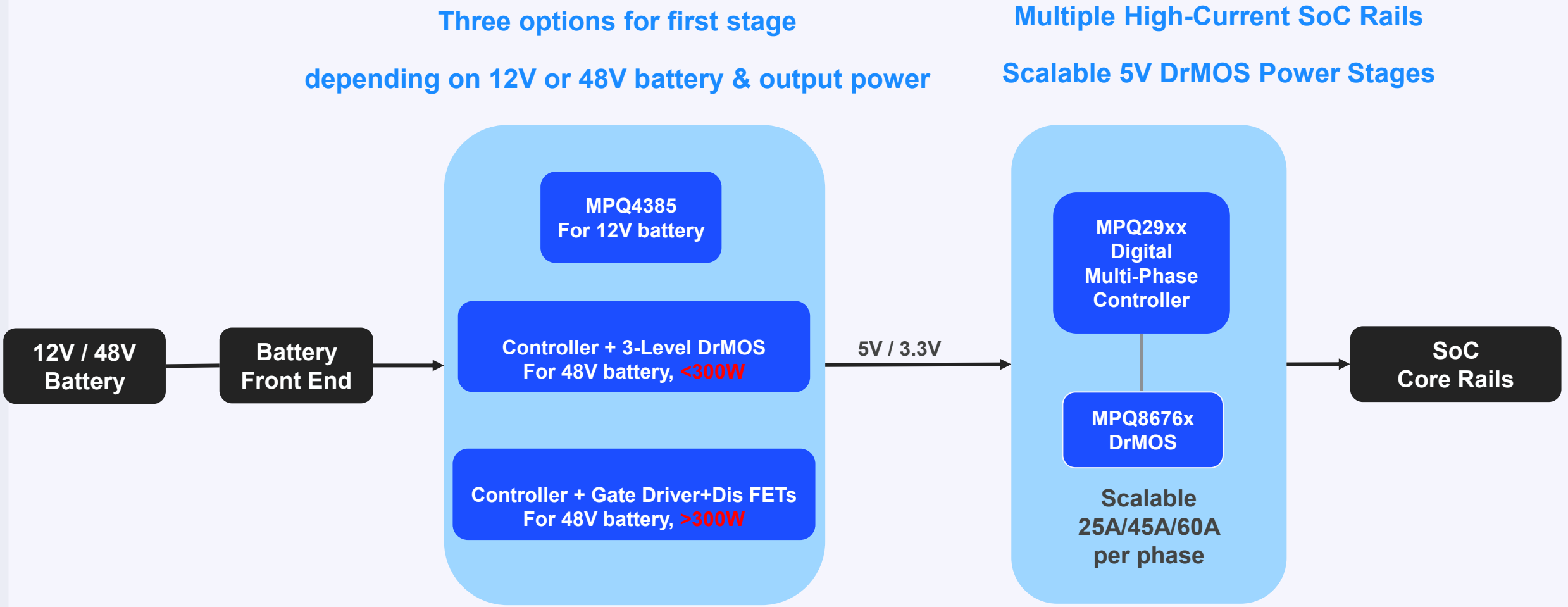
An Example Robotics SoC Core Power Tree



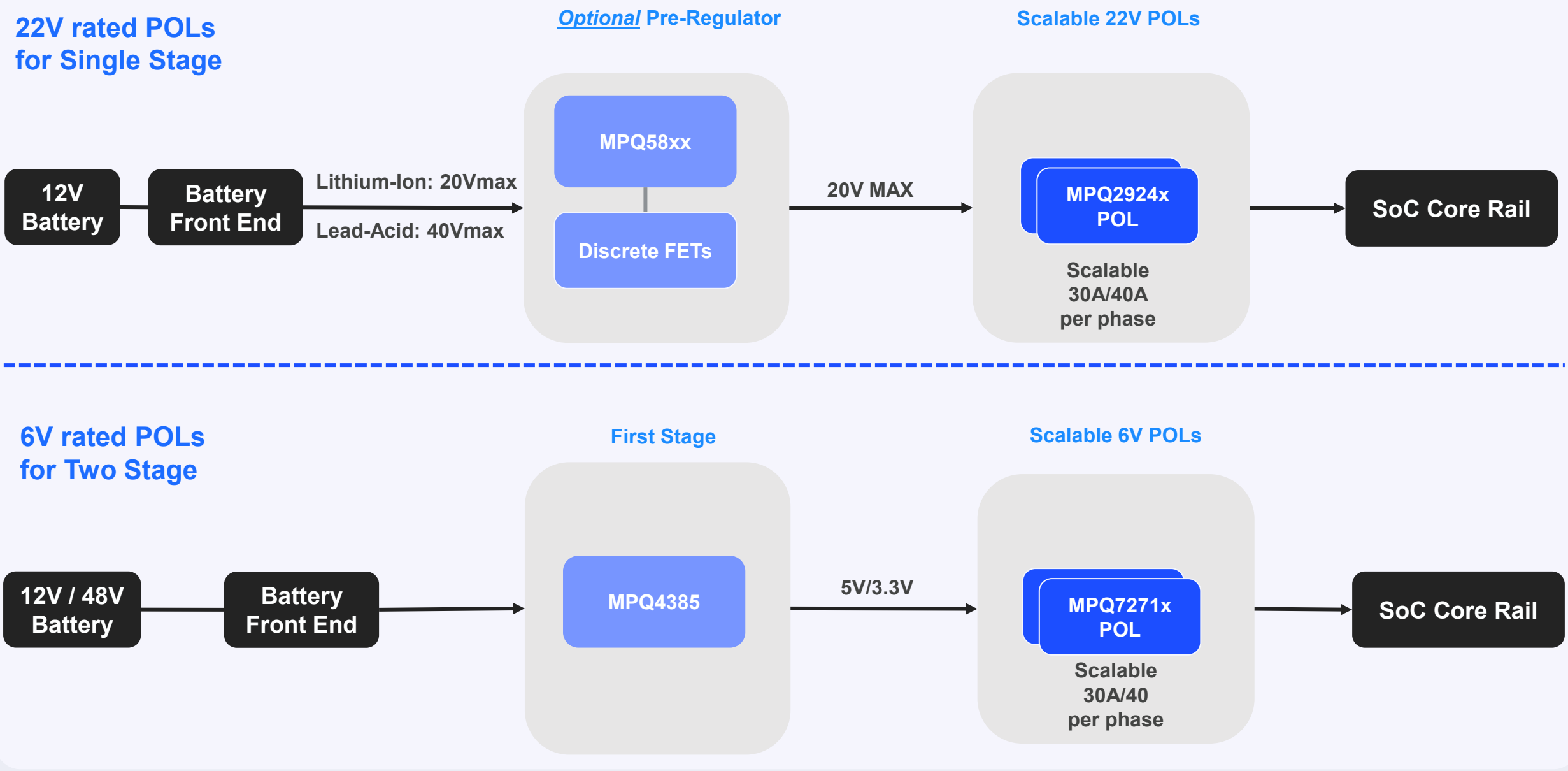
48V Battery w/ 2-stage conversion



12V / 48V Battery: Two Stage Power Conversion



Stackable & Compact High Current PoLs



Multi-Phase Digital Controllers + DrMOS & PoLs for SoC Power

MPQ72957FS
4-Rail / 8-Phase, AVSBUS/I2C,
7x7 QFN

MPQ2946
3-Rail / 8-Phase, I2C,
7x7 QFN

MPQ29125
3-Rail / 8-Phase, SVI3/I2C,
6x6 QFN

MPQ2967
2-Rail / 4-Phase, PWMVID/I2C,
6x6 QFN

MPQ2977
2-Rail / 6-Phase, I2C,
6x6 QFN

MPQ2977
2-Rail / 6-Phase, I2C,
6x6 QFN

Multi-Phase Digital Controllers

MPQ86960-A
22V, 50A, 5x6 LGA

MPQ86970
22V, 50A, 5x6 LGA, CFP

MPQ86970
22V, 50A, 5x6 LGA, CFP

MPQ86970
22V, 50A, 5x6 LGA, CFP

MPQ86970
22V, 50A, 5x6 LGA, CFP

Intelli-phase DrMOS

MPQ29261
22V, 18A, 2-bit VID, 3x4 QFN

MPQ81811
22V, 8A, 2-bit VID, 2x3 QFN

High Current Converters

MPQ2967: 2-Rail, 4-phase Digital Controller

MPSafe™ ASIL-D

Customer Benefits

ACP™(Advanced COT PWM) for lower output capacitance & predictable EMI

Digital control for flexibility, optimized tuning, fast design cycles

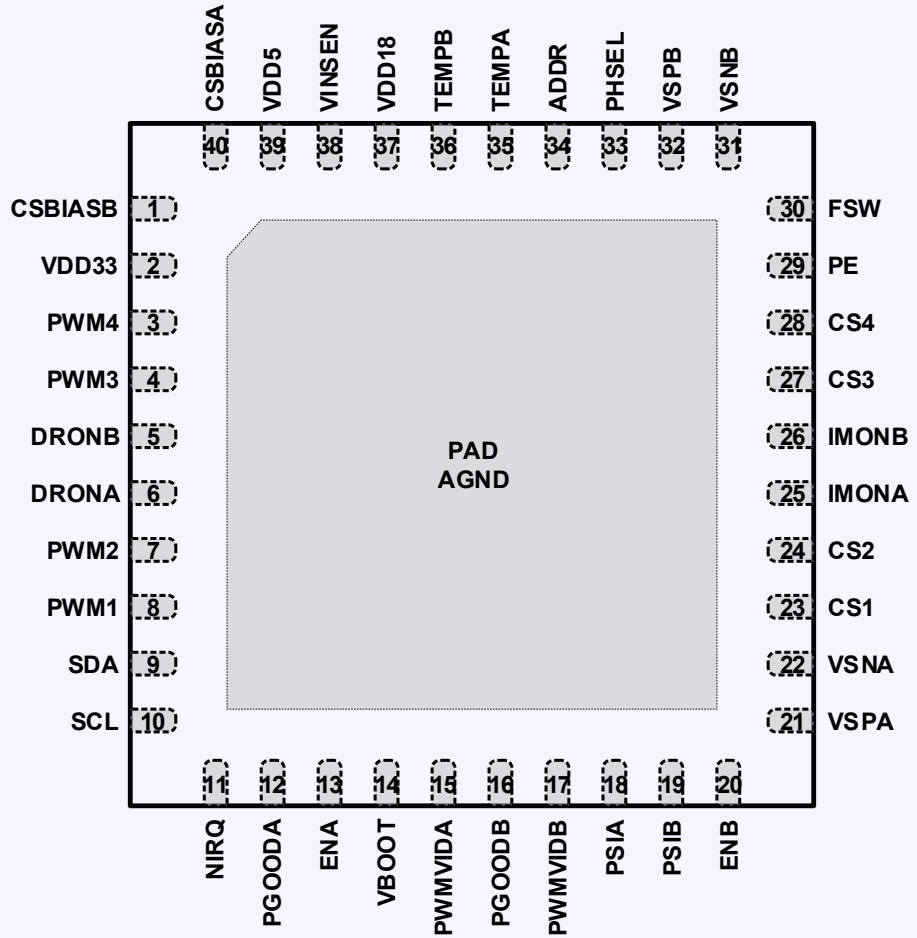
Features

- PMBus for programming and monitoring
- PWM-VID interface compliant
- Built-in MTP to store customer configuration
- UVLO/OVP/UVP/OCP/OTP protections
  - With register telemetry flag
- Input voltage, output voltage and current, and regulator temperature monitoring
- Automatic loop compensation / phase shedding / Ph-to-ph active current balancing
- Runtime register CRC, and PEC mismatch check
- Separate EN for each rail

Applications

- Robotics SoC core rails

Released



QFN-40

6mm × 6mm with 0.5mm pitch

MPQ86960-A: 50A Intelli-phase DrMOS

Customer Benefits

Monolithic design offers higher Fsw to reduce inductor, capacitor size

Optimized process technology for best efficiency to extend EV battery range

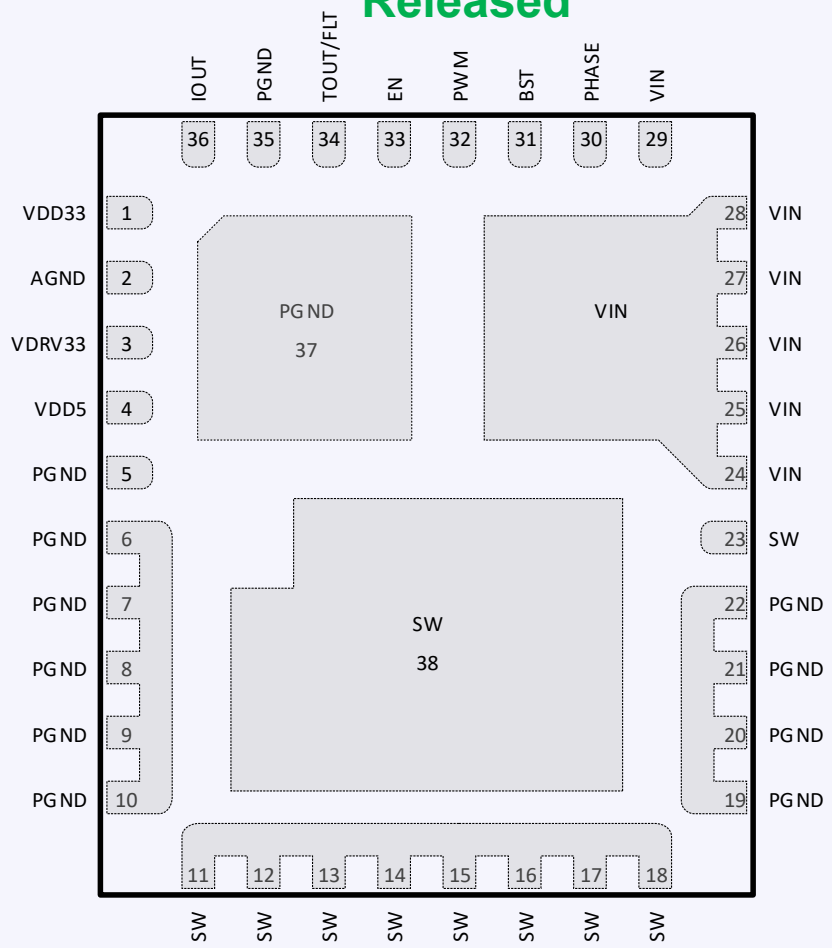
Features

- Wide 3V to 22V operating input range
- 5V VDD input
- VDRV33 and VDD33 supported by internal LDO
- Current sensing with Accu-Sense™
- Temperature sensing
- Accept tri-state PWM input
- Current limit protection
- Over temperature protection
- Fault reporting

Applications

- Robotics SoC core rails

Released



LGA 5mm × 6mm

with 0.5mm pitch

MPQ2924x: 22V High/Current Power Converters

Customer Benefits

ACP™ (Advanced COT PWM) for lower output capacitance & predictable EMI

Digital control for flexibility, optimized tuning, fast design cycles

Features

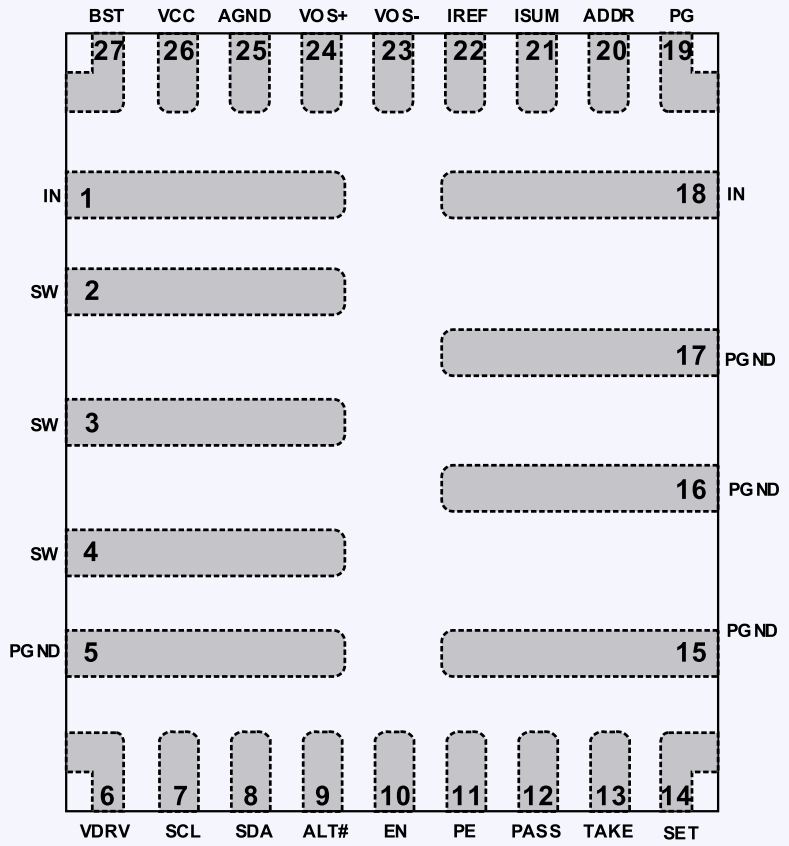
- Configurable to single or multi-phase
- PMBus for programming and monitoring
- Built-in MTP to store customer configuration
- UVLO/OVP/UVP/OCP/OTP protections
  - With register telemetry flag
- Automatic loop compensation
- Digital load line regulation
- Input voltage, output voltage and current, and regulator temperature monitoring

Part number	Voltage & Current ratings
MPQ29240	3.1V – 22V, 40A
MPQ29241	3.1V – 22V, 30A

Applications

- Robotics SoC core rails

Sampling now



QFN-27

5mm × 6mm

Thank You