RACK & POWER



+/-400V / 800V On-Board Power Delivery Requirements

Lu Jian (LJ) *Onboard Power Technical Lead Manager, Google*

Sachin Madhusoodhanan *Senior Power Engineer, Google*

James Sun *Principal Systems Engineering Manager, Microsoft*

Shengwen Xu *Power Systems Engineer, Meta*

Michelle Badal *Global Commodity Manager / OCP Workstream Contact, Google*



Agenda

- Background
- Onboard power ecosystem evolution: Industry, Google, Meta and Microsoft
- +/-400V/800V to 50V or 12V Specifications
- Onboard power design quality challenges
- Power Entry onboard power qualification requirements
- Call to Action and Next Steps
- Open Discussion

Background

- Unified specifications proved essential for resilient, multi-vendor supply chains during the 12V to 48V transition.
- **In 2024:** Google, Microsoft, Meta, and industry members released the 48V Design and Qualification Checklists through OCP.
- **Today:** High-density AI workloads require exceptional dynamic load handling and supply shortages highlight the need for design-driven supply chain resilience.
- Transitioning from 48V to +/-400V/800V on-board power delivery enables higher power density, end-to-end efficiency, and better power quality directly at the ASIC level.
- **Call to Action:** Google, Meta, and Microsoft are launching a new OCP Workgroup in Q4 2026 to create standardized power module specifications and qualification criteria, targeting a 2H 2027 release.

Enable Technology & Improve Supply Chain Efficiency



Strategies to enhance technology enablement and supply chain security following recent IC shortages:

- **Standardize Specifications:** Simplify requirements for IC suppliers to streamline production and boost overall output efficiency.
- **Ensure Supply Continuity:** Secure a reliable technology pipeline to and improved supply and supply chain operations.
- **Drive Business Demand:** Strengthen market demand for these solutions to support long-term business health.
- **Improve Resiliency:** Mitigate risk by qualifying multiple partners, effectively eliminating single points of failure.
- **Standardize Footprints:** Implement common hardware layouts to ensure cross-vendor compatibility and operational flexibility.

Industry Onboard Power Ecosystems Overtime

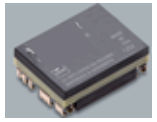
12V systems

48V systems

Legacy 2-stage solution:
1st stage isolated & regulated 48V-12V, leveraged from legacy telecom industry.


+


1-stage solution:
48V-PoL direct conversion



Google 48V architecture first announced at OCP.

Google 48V STC based 2-stage architecture disclosed at APEC 2017



48V-PoL 1-stage solutions released.



Nvidia first 48V GP (DGX-2)



48V 2-stage ecosystem established:
1st stage 48V-12V (discrete non-isolated fixed ratio & regulated converters)





48V 2-stage ecosystem further evolved:
1st stage 48V-bus (12V or lower, modularized non-isolated fixed ratio & regulated converters);



2nd stage multiphase TLVR adopted by mainstream servers for fast transients.

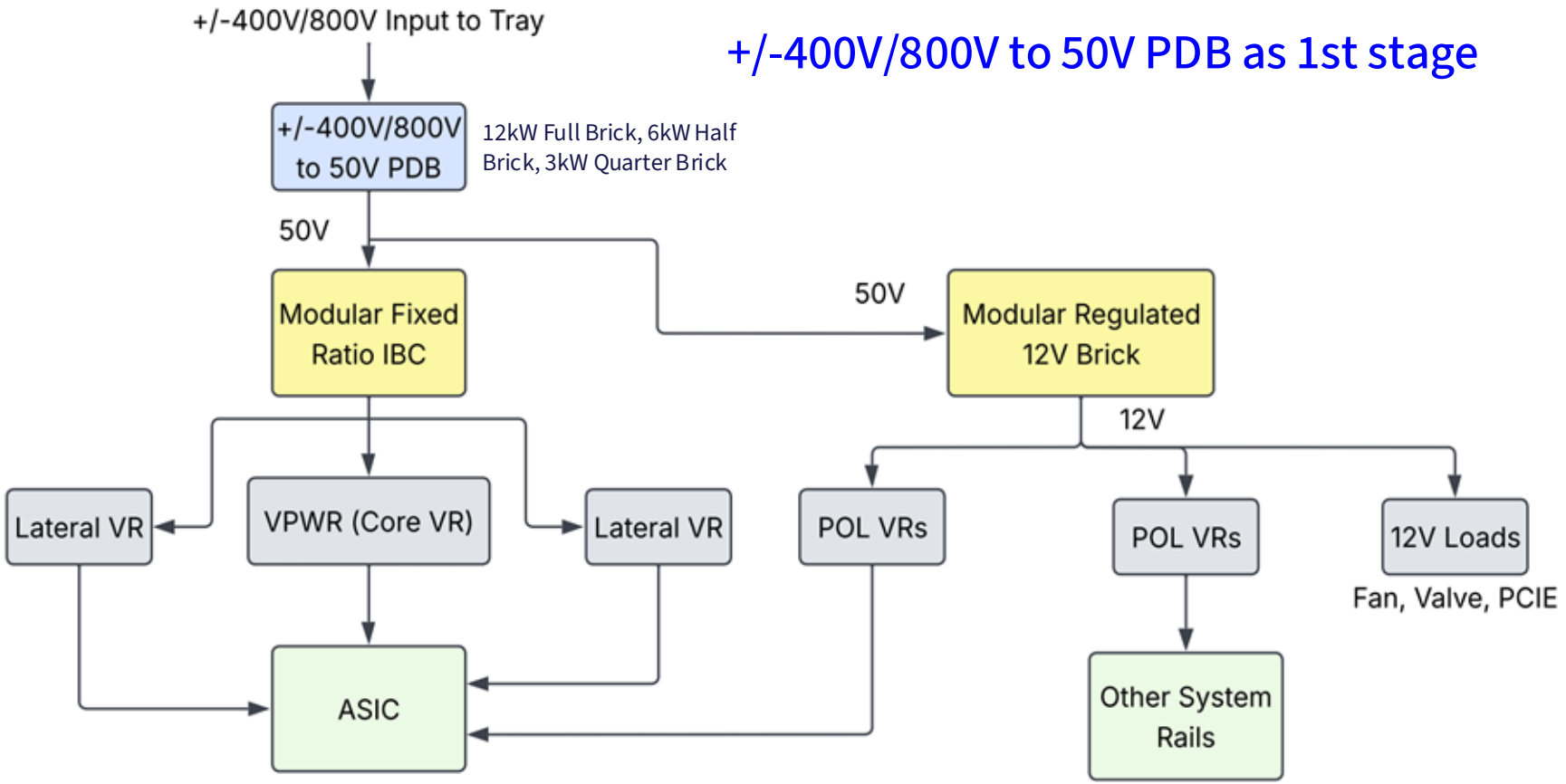


48V-PoL 1-stage solutions (custom VRM module designs)

+/-400V/800V solutions

2012 2016 2018 2020

+/-400V/800V Onboard Power Evolution

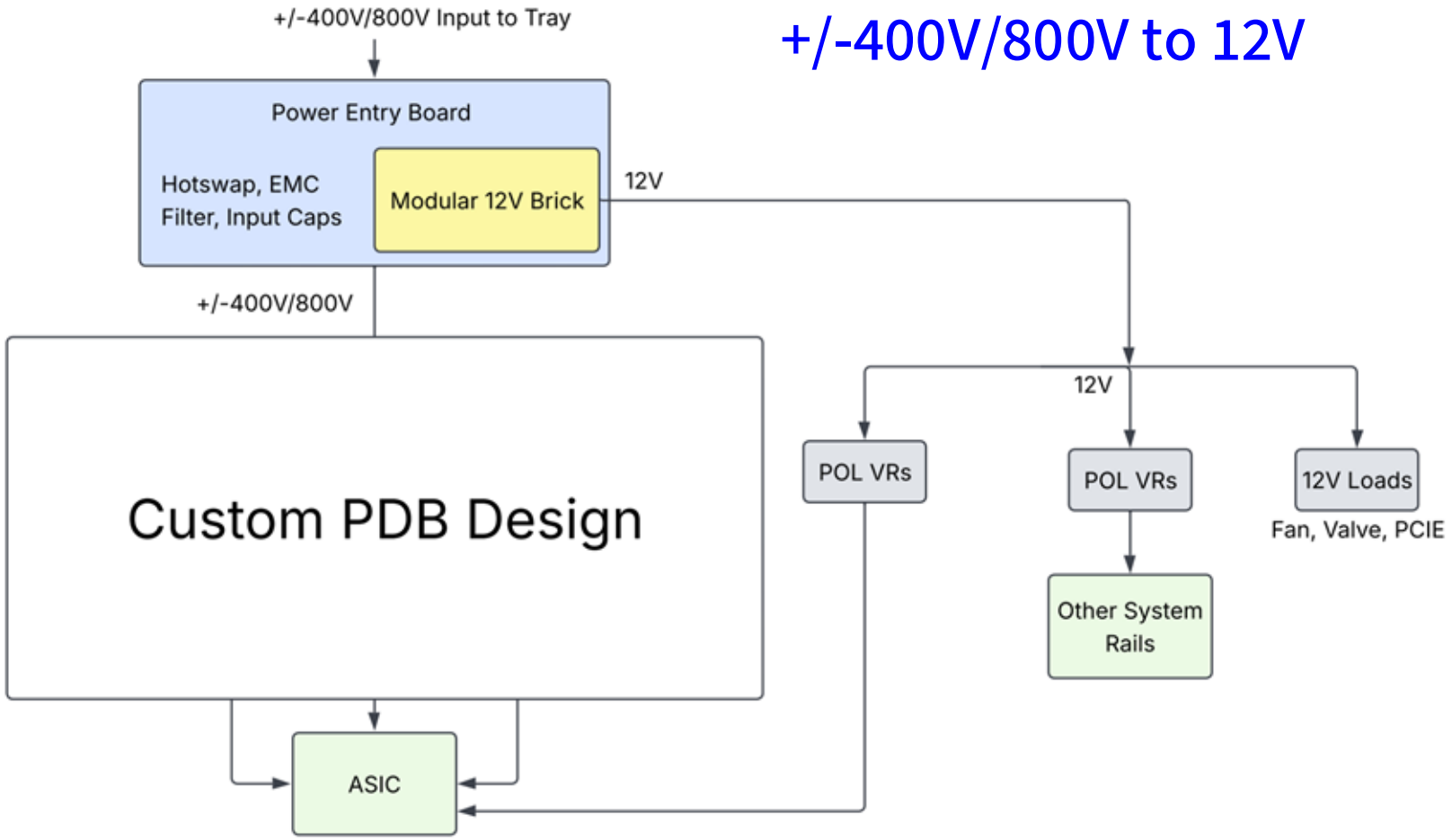


+/-400V/800V to 50V PDB as 1st stage

- Scalable High Voltage Full, Half and Quarter bricks.
- Enabling ecosystem development.
- Existing 48V downstream VR design.
- Lesser isolation requirements for +/-400V before transitioning to 800V.
- Power quality & reliability.
- Enable common footprint & optionality.

Beyond 48V Power Distribution Board (PDB)

+/-400V/800V Onboard Power Evolution



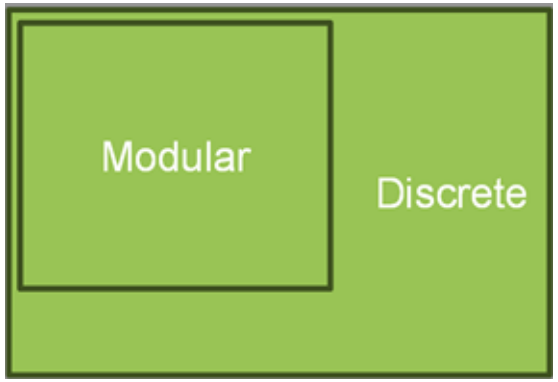
+/-400V/800V to 12V

- PDB densification - Higher tray power density.
- +/-400V/800V closer to ASIC - Higher end-to-end efficiency.
- Modular 12V brick design for lateral power.
- Higher isolation requirements for 800V (reinforced).
- Power quality & reliability.
- Vendor ecosystem.
- Enable common footprint & optionality.

Beyond 48V Power Distribution Board (PDB)

Pros & Cons: Discrete vs. Modular Implementation

Parameter	Discrete	Modular
Power Density W/mm^2	Lower	Higher, depending on the solution can be up to 2x
Efficiency ~98%	Decimal points higher	Decimal points lower - OPEX impact
System Design and Implementation	Larger board space, no redundancy	Enables another vertical placement, +1 redundancy, cold plate cooling, multi sourcing, etc.



1st stage solutions

Top-view Benefits of Quality Partnership

Industry-wide collaboration on standard ±400VDC/800VDC power solutions expands reusable ecosystem components and enables scalable, high-quality AI data center architectures.

Greater adoption enhances design flexibility, standardizes qualification, and reinforces reliability and supply chain resilience for both internal and external platforms.

Standardized qualification methodologies enhance product stability, robustness, and long-term reliability.







+/-400V/800V DC-DC Module Key Specifications

Vout	50V (fixed ratio)	12V (fixed ratio)/12V (regulated)
TDP	**12kW (Full Brick); 6kW (Half Brick); 3kW (Quarter Brick)**	**3kW (fixed ratio, Quarter Brick)/2.5kW (regulated, Quarter Brick)**
Vin nominal	+/-400V/800V	
Vin tolerance	+/-10%	
Height	14mm	
Vout ratio tolerance (DC+AC)	+/-3%	
Parallel operation	Passive droop current sharing with impedance match (fixed ratio)	Passive droop current sharing with impedance match (fixed ratio)/ Active current sharing (regulated)
Efficiency target	>98.5% peak; >98% for 25%-100% of full-load	>96.5% peak; >95.5% for 25%-100% of full-load
Transient power	Supports >150% TDP for 50ms	
Output capacitance	500uF/kW	5mF/kW
Isolation	Yes, 800V Reinforced	
Protection	Vin UVP/OVP, Vout UVP/OVP, OCP and OTP	
Start-up	Supports pre-biased start-up	
PMBUS & Blackbox	Yes & Yes	
Footprint (Soldering method) **MSL Rating**	DOSA Compliant 3 or Better	
EMC & Safety compliance	IEC/EN/UL/CSA 62368-1	

Onboard Power Quality Requirements

Below is an outline of the requirements for modular power design to enhance scalability and reliability while enabling multi-vendor sourcing and reducing qualification burdens.

The primary objectives and technical requirements include:

- Design Architecture: Modular solutions with a common footprint are preferred and accelerate design and validation, improve quality, and minimize system redesign during multi-vendor sourcing.
- Performance Specifications: Defined requirements for output voltage regulation, ripple/noise, transient response, startup/shutdown sequencing, current sharing, and fault recovery.
- Compliance & Safety: All designs must comply with +/-400V/800V IEC/UL 62368-1 safety and EMC standards for high-voltage delivery.
- EMC Standards: Performance must meet rigorous conductive and radiative emission standards.
- AI Workload Stability: Power quality must remain stable under system-level dynamic loading conditions representative of high-density AI environments.
- Efficiency: Enhanced efficiency shall be achieved through integrated power and thermal co-design.

Power quality performance must be maintained when modules operate in parallel to ensure consistent reliability.

Call to Action

We invite industry members* to the “+/-400V/800V Onboard Power Delivery” OCP Workgroup to:
Join in finalizing, developing and implementing the +/-400V/800V power module solution specification and qualification criteria proposed by Google, Microsoft and Meta for target availability starting 2H27.

Workgroup participation types: Extended Workgroup and Core Workgroup. Where the Core Workgroup is expected to assign resources for the review, finalize development of qualification criteria, specification and worksheets

Next Steps:

- If interested request to join by emailing mbadal@google.com by October 30th!
- Target first meeting is in Q4’26 to discuss the timeline of the workgroup activities

*End customer and supply base

Additional Contributors Acknowledgment

Google:

- Chee Chung - Senior Director Engineering
- Gregory Sizikov - Senior Manager Engineering
- Mobashar Yazdani - Senior Manager Global Commodity Management
- Ali Eltoukhy - Senior Manager Global Commodity Management, Power

Microsoft:

- Hao Yang, Category Sourcing Director

Meta

- Dan Kim, Commercial Sourcing Manager
- Anthony Chan, Power Systems Engineer

Open Discussion

