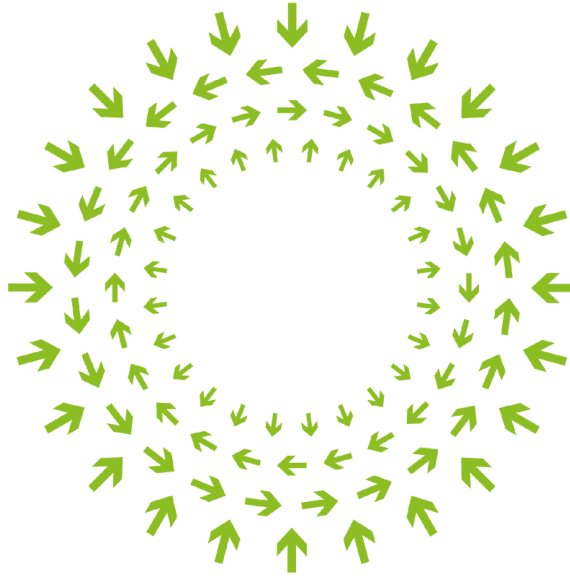




OPEN

Compute Project

48V Onboard Power Solution Requirements

Base Specification Version 1.0.0

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2. Acknowledgements

The Contributors of this Specification would like to acknowledge the following for their feedback:

List all companies or individuals who may have assisted you with the specification by providing feedback and suggestions but did not provide any IP.

3. Compliance with OCP Tenets

3.1. Openness

By providing a standardized 48V 1st Stage Power Design solution overview for OCP, it provides other Hyperscalers and suppliers with the guidelines and inputs to anticipate the electrical, mechanical and thermal requirements.

3.2. Efficiency

Contributes to the reduction of design, development cost as well as efficiency in supply chain management by providing a common footprint 48V 1st Stage Power Design. The common footprint also allows for efficient design reviews and allow for suppliers to do design reuse.

3.3. Impact

By providing this contribution we are empowering Hyperscaler or suppliers to achieve faster time-to-market development by investing early and determining their roadmap of requirements.

3.4. Scale

With the continued increase in the Data Center Power requirements, anticipating and achieving power efficiency is paramount. The creation and sharing of the 48V 1st Stage Power Solution overview can empower not just other Hyperscalers and suppliers that provide direct solutions, but also to subtier suppliers who support those solution level suppliers.

3.5. Sustainability

Providing this 48V 1st Stage Power common footprint solution for Data centers enables efficient and responsible power consumption. The common footprint allows for efficiencies and responsible supply chain development and management that help suppliers only invest and develop in solutions that will likely meet customer needs.

4. Objective

This document details the general feature requirements and operating characteristics of a 48V power solution for high-performance and high-density 48V rack applications.

The detailed design information on 48V power solutions provided in this specification is based on the alignment among Google, Microsoft, and Meta with the workstream.

5. Background

Google, in partnership with Microsoft, presented Onboard Power Delivery Specs and Qualifications at OCP 2023. The presentation included an overview of onboard power evolution shown in figure 1 and a comparison between module and discrete designs shown in Table 1. This document represents a continuation of the discussions regarding the final specifications.

The partnership aims to drive common solutions in 48V power, specifically by establishing more common footprint blocks, improving supply chain efficiency, increasing design flexibility and reducing qualification processes during product development, and standardizing industry guidelines related to reliability and testing.

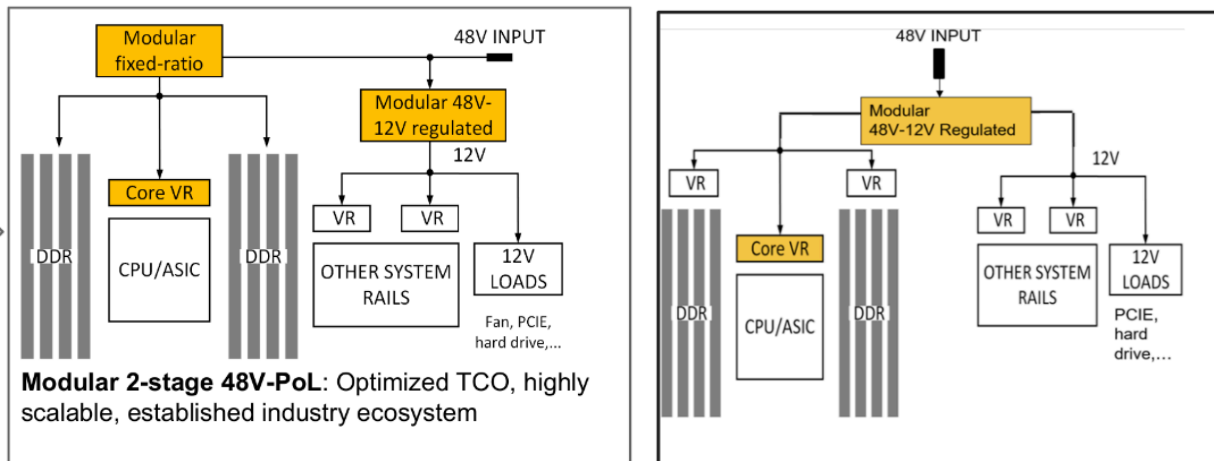


Figure.1 Google and Microsoft onboard power evolution

Table.1 Pros and cons of discrete vs. modular for system design and implementation

Solution	Modular	Discrete
Power density W/mm2	Higher	Lower
Efficiency	Similar. 98% at 50% of load	
System design	Common footprint	Flexibility of board design

6. Specifications for Regulated Power Solutions

Electrical

Absolute Maximum Rating:

- Input voltage: 65 VDC (continuous) and 70 VDC (100 msec)
- Operating ambient temperature: -40°C to 85°C
- Storage temperature: -55°C to 125°C

Input Characteristics :

- Operating input voltage: 40 VDC to 60 VDC (Compliance with ORv2)
- Input under-voltage lockout: 37 VDC turn on and 35 VDC turn off
- Power consumption at no-Load ($P_{out} = 0W$): <10 W

Output Characteristics:

- Output power level (TDP): 600W, 860W, 1300W, 1600W, 2000W
- Peak load and duration minimum requirements for the following:
 - 200% of TDC for 0.5 msec
 - 175% of TDC for 5 msec
 - 150% of TDC for 50 msec
 - 130% of TDC for 100 msec
- Output voltage set point: Initial voltage is 12.2 VDC at no load
- Adjustable range: 8 VDC to 13.2 VDC
- Line regulation: 0.5% of $V_{o,set}$
- Load regulation: 0.1% of V_o (0 - 50% of $I_{o,max}$); 0.4% of V_o (0 - 100% of $I_{o,max}$).
- Output voltage ripple and noise: +/- 1% of output setpoint for peak to peak voltage
 - Note the external capacitive load requirement. 20MHz for oscilloscope bandwidth
- Capacitive loading (external): 1,000uF to 20,000uF

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Dynamic Characteristics:

- Load transient voltage deviation¹: 3% of V_{out} considering load-line
- Output voltage rise time: <10 msec

1. Test output regulation with fast dv/dt line transient (V_{in} : 30V/ms upslope and 10V/ms downslope); (Current step: 10%-90% of Thermal Design Current (TDC), 10A/us, support frequency sweep 200Hz-50KHz with 50% duty cycle)

Thermal steady state efficiency @ 48-54V V_{in} / 12V V_{out} : at 55°C ambient temperature

100% of Thermal Design Power (TDP)	Peak	10% of TDP
97%	98%	96%

Built-in Protection:

- Adjustable over current and short circuit. Slow Overcurrent Protection (OCP) and Fast OCP (Hiccup mode)
- Adjustable input/output over/under voltage protection
- Over power and over temperature

Monitoring Accuracy:

	Input Voltage	Output Voltage	Output Current ¹	Temperature	Output Power
Min and Max Specification	±125 mV	±2 %	±3 %	±5 °C	±5 %

Note 1: 10% accuracy < 20% of TDC and 3% accuracy when > 20% of TDC

Mechanical

Mechanical Dimensions:

- 58.4mm × 37mm × 12mm; 58.4mm × 23mm × 12mm (pin length 2.5-3.8mm) for higher power version

Weight:

- <100 grams (with baseplate)

Basic Pin Definition:

Pin	Designation	Function
1	+In	Positive Input
2	RC	Remote Control
3	-In	Negative Input
4	-Out	Negative Output
5	+Out	Positive Output

Signal Pin Definition: (DOSA, dual output pin for high current application)

Pin	Designation	Function
1	PG	Power Good
2	DGND	PMBus Ground
3	SDA	PMBus Data
4	SALERT	PMBus Alert Signal
5	SCL	PMBus Clock
6	ADDR	PMBus Address
7	IMON	Current Share

Shielding option:

- Baseplates with grounded or non-grounded options

Thermal

Thermal solution:

- Baseplate and open-frame options
- Temperature reporting for the hottest component

Reliability

Refer to 48V 1st Stage Power Solution Qualification Checklist rev 1.0

Compliance

Conducted EMI measured according to EN55022/ EN55032, CISPR 22/ CISPR 32 and FCC part 15J.

DC/DC regulators are designed in accordance with the safety standards IEC/EN/UL/CSA 62368-1

General Requirements

- Support PMBus (100KHz and 400KHz)
 - Define the noise level/immunity and suggested filter design
- Blackbox
 - 4KB non-volatile memory is needed
 - Telemetry for Vin, Vout, Iout, temperature and duty, status registers, regulation state of module, current and prior to fault, and time stamp
- Adjustable output voltage using PMBus with margin up and down control
- Active current sharing accuracy:
 - 5% when <20% of load, 3% between 20%-50% of load, and 2% > 50% of load
- Remote control (EN)
- Soft start power up and soft stop
- Capacitive loading - The power supply must be stable and meet all requirements with the following capacitive loading ranges.
 - Minimum: 1,000uF. Maximum: 20,000uF
- Provide maximum allowed peak power capability curve according to different input voltage and peak power duration
- Provide maximum allowed output power curve vs. ambient temperature and air velocity
- Soldering: Wave soldering and Pin-in-paste (Moisture Sensitivity Level (MSL) rating of 3)
- Remote in-field programmable feature

7. Specifications for Fixed-ratio Power Solutions

Electrical

Absolute Maximum Rating:

- Input voltage: 65 VDC (continuous) and 70 VDC (100 msec)
- Operating ambient temperature: -40°C to 85°C
- Storage temperature: -55°C to 125°C

Input Characteristics :

- Operating input voltage: 40 VDC to 60 VDC
- Input under-voltage lockout: 37 VDC turn on and 35 VDC turn off
- No-Load output current ($P_{out} = 0W$): < 500 mA

Output Characteristics:

- Output power level (TDP): 800W, 1000W, 1500W
- Fixed-ratio factor: 4, 5, and 8
- Peak load and duration:
 - 300% of TDC for 1 msec (optional)
 - 250% of TDC for 10 msec
 - 200% of TDC for 100 msec
- Output voltage ripple and noise: 100 mVDC_{p-p}
- Capacitive loading: 100uF to 10,000uF

Dynamic Characteristics:

- Load transient voltage deviation: ±80 mVDC
- Output voltage rise time: <50 msec (From Vin applied to 100% of Vout)

Efficiency @48Vin:

100% of TDP	50% of TDP	10% of TDP
97.5%	98.5%	96%

Built-in Protection:

- Adjustable over-current and short-circuit. Slow OCP and Fast OCP (Hiccup mode)
- Adjustable input/output over/under voltage protection
- Over-power and over-temperature

Monitoring Accuracy:

	Input Voltage	Output Voltage	Output Current ¹	Temperature	Output Power
Min and Max Specification	±125 mV	±2 %	±3 %	±5 °C	±5 %

Note 1: 10% accuracy < 20% of TDC and 3% accuracy when > 20% of TDC

Mechanical

Mechanical Dimensions:

- 23mm × 17mm × 10.2mm (with baseplate); 23mm × 17mm × 8mm (without baseplate)

Weight:

- <20 grams (with baseplate)

Basic Pin Definition:

Pin	Designation	Function
1,4	+In	Positive Input
2	PG	Power Good
3	EN	Enable
5	-In	Negative Output

Signal Pin Definition :

Pin	Designation	Function
1	ADDR	PMBus Address
2	SDA	PMBus Data
3	SCL	PMBus Clock

Shielding option

- Baseplates with grounded or non-grounded options

Thermal

Thermal solution

- Baseplate and open-frame options
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General Requirements

- Support PMBus (100KHz and 400KHz)
 - Define the noise level/immunity and suggested filter design
- Blackbox
 - 4KB non-volatile memory is needed
 - Telemetry for Vin, Vout, Iout, temperature and duty, status registers, regulation state of module, current and prior to fault, and time stamp
- Current sharing capability: <10%
- Remote control (EN)
- Soft start power up and soft stop
- Capacitive loading - The power supply must be stable and meet all requirements with the following capacitive loading ranges.
 - Minimum: 1000uF. Maximum: 10,000uF
- Provide maximum allowed peak power capability curve according to different input voltage and peak power duration
- Provide maximum allowed output power curve vs. ambient temperature and air velocity
- Soldering: Surface mounting
- Remote in-field programmable feature