Lateral power to Vertical power
横向功率到垂直功率傳輸

FAE
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Enabling the Highest Performance AI Accelerators with Vertical Power Delivery
Challenge in Powering AI Processors

- Increasing power
  - Decreases power efficiency
    - increasing distribution losses
  - Constrains system design
    - power consumes more board area
  - Sacrifices the quality of power delivered
    - added parasitics
  - Increases thermal demands
    - how to keep cool?
  - Can limit XPU operating performance if power demands are not met

Progression of Customer CPU/GPU Peak Current Requirements

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**Progression of Customer CPU/GPU Peak Current Requirements**
System performance demands drive rapidly increasing load power.

Moving PDN to higher voltages eases the delivery and distribution of higher power.

High-density needed at the point of load to increase performance and efficiency.

The power module company with, by far, the highest performance and density.

Power = Voltage x Current
Power distribution loss from the VR to the processor
48 V Direct to CPU: Single Stage Conversion

4 Key Components Replace an Entire Collection of Conventional Devices

- PRM (Pre-regulation Module) regulates a 48 V line input
- VTM (Voltage Transformation Module) transforms the regulated 48 V to CPU power

48 VDC

Conventional Multiphase

PI3020 offers digital control, telemetry, and CPU communication
PRM and controller placed on board edge

Only VTM itself placed by CPU

PDN of VR13 Board
The Last Mile (Last Inch)

200µΩ to 600µΩ

100µΩ to 300µΩ

Socket/Heatsink Assembly

CPU

VR
Power on Package – Eliminates the Last Inch

• Power-on-Package practically eliminates the power delivery network

• Moves high current delivery from the VR off the motherboard and places it adjacent to the XPU

• Power-on-Package solution enables higher current delivery for maximum XPU performance
48V Direct to CPU
PRM/VTM Re-partitioned to MCD/MCM

How to Eliminates the Last Inch??

54Vin → PRM → Inductor → Factorized Bus (~44VDC*) → VTM

Core Voltage → CPU
48V Direct to CPU
MCD/MCM Power on Package
Lateral Power Delivery : Power-on-Package

- MCMs mounted on sides of XPU
- Reduces PDN losses
- Reduces server board layer count
- Improves transient performance
- Extends peak current capability to >1,000A

Lateral Power Delivery (LPD)
Typical PDN resistance: 70µΩ
PDN loss at 1,000A: 70 Watt
Comparison of 12V Multiphase vs. Factorized Power

Older Nvidia SXM2 Card
Using
Conventional 12V Multiphase

Latest, higher power, Nvidia SXM3 Card
Using
48V Vicor Power-on-Package
Gyoukou Server
System Enabled by Power on Package
Does Lateral Power Delivery Good Enough?
The Last Mile (Last Inch)

Socket/Heatsink Assembly

40µΩ to 70µΩ
Enabling the Highest Performance AI accelerators with…
Vertical Power Delivery
Vertical Power Delivery

- MCM mounted on bottom of XPU
- Reclaims valuable space around the XPU
- Minimizes PDN loss
- Integrates PoL capacitance
- Maximizes system efficiency
- Maximizes XPU performance

Vertical Power Delivery (VPD)
Typical PDN resistance: 10µΩ
PDN loss at 1,000A: 10 Watt
Vertical Power Delivery
For Immediate Release

Semiconductor Industry: KYOCERA and Vicor to Collaborate on Advanced Power-on-Package Solutions

Collaboration will maximize Artificial Intelligence performance and minimize time-to-market for new processor designs

Andover, MA and Kyoto, Japan – April 10, 2019 – Kyocera Corporation (TYO:6971) and Vicor Corporation (NASDAQ: VICR) will collaborate on next-generation Power-on-Package solutions to maximize performance and minimize time-to-market for emerging processor technologies, the companies announced today. As a part of the collaboration between the two technology leaders, Kyocera will provide the integration of power and data delivery to the processor with organic packages, module substrates and motherboard designs. Vicor will provide Power-on-Package current multipliers enabling high density, high current delivery to processors. This collaboration will address the rapid growth of higher performing processors, which has created proportionate growth and complexity in high-speed I/Os and high current consumption demands.

Vicor’s Power-on-Package technology enables current multiplication within the processor package, allowing for higher efficiency, density, and bandwidth. Providing current multiplication within the package can reduce interconnect losses by up to 90 percent, while allowing processor package pins, typically required for high current delivery, to be reclaimed for expanded I/O functionality. Vicor’s Power-on-Package solutions were featured at the NVIDIA GPU Technology Conference 2018 and China ODCC 2018 Summit. Vicor’s advanced Power-on-Package technology enables Vertical Power Delivery (VPD) from the bottom side of the processor. VPD virtually eliminates Power Delivery Network (PDN) losses while maximizing I/O capability and design flexibility.

Kyocera’s proprietary solutions to optimize processor performance and reliability are based on decades of experience in package, module and motherboard manufacturing for customers worldwide. Kyocera has cultivated design expertise by applying Vicor’s Power-on-Package devices in multiple applications. By utilizing its design technology, simulation tools and manufacturing experience, Kyocera provides optimal designs for complex I/O routing, high-speed memory routing, and high-current power delivery. Through collaboration, Kyocera and Vicor will bring new solutions for AI and high-performance processor applications to market.
Summary of 48V VR PoL Options

**NBA - NBM to Multiphase**
- Re-use existing Multiphase design
- Commonality between 12V and 48V server solutions

**48V Direct to CPU – PRM/VTM On Motherboard solution**
- Higher efficiency & density 48V solution
- Lower noise and faster transient response
- PRM can be remote from prime XPU real estate

**48V Direct to CPU – MCD/MCM On Motherboard solution**
- Low profile current multiplier (MCM) placed closer to XPU
- Lower cost, high current XPU solutions >130A

**48V Direct to XPU – MCD/MCM Power on Package**
- Eliminates interconnect losses (bypassing traditional PDN)
- High efficiency and current capability up to 1000A

**48V Direct to XPU – MCD/MCM Power on Chip**
- Modular Current Multiplier on Chip
- Highest efficiency and current density
OCP Summit – March 19

Demonstrating Immersion cooling with 3M
PEZY Gyoukou Server using Vicor front end and Power on Package
Thank you

Questions?

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