Accelerating 48V Adoption in Your Data Center

— Two-Stage 48V SWC-Regulated Solution

White Paper

October 2018

Contents

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Introduction

With rapid development of cloud computing, the energy used in US data centers is estimated to exceed 190 billion kwr by 2020. Taking into account the increasing demands of high power processors and accelerators, it is inevitable for data center operators to re-architect their power delivery strategy.

As discussed in Wiwynn's previous whitepaper, "48V: An Improved Power Delivery System for Data Centers", 48V is proven an efficient power distribution architecture, and the adoption of 48V in data center ecosystem is accelerating. Google, for example, has implemented 48V in its data centers and contributed a 48V rack power specification to the Open Compute Project (OCP) community. NVIDIA also employs 48V in its latest GPU product lines to address the challenge of increasing power demand.

The 48V-to-12V two-stage power conversion modules (so-called two-stage solution) and "48V to point of load (PoL)" are the two most popular approaches for 48V implementation. PoL solution offers optimized 48V delivery. However, the component cost is higher and requires extensive resource for board re-design. In addition, the 48V rail running on mother board could introduce noise coupling issue and cause signal integrity (SI) challenges. In addition, bigger lay-out space and design efforts are required and will further raise the cost. The two-stage solution shortens 48V IT solution development cycle with lower cost but power efficiency might be discounted with legacy technology for the additional stage power conversion.

To accelerate 48V adoption in data centers, Wiwynn continuously invested in 48V development and at OCP US Summit 2018, announced the advanced two-stage 48V solution which expedites 48V adoption, leverages existing IT system design and provides uncompromising power efficiency. In the rest of this whitepaper, we will detail the design concept with performance comparison. This provides data center community with high power delivery efficiency 48V solution.

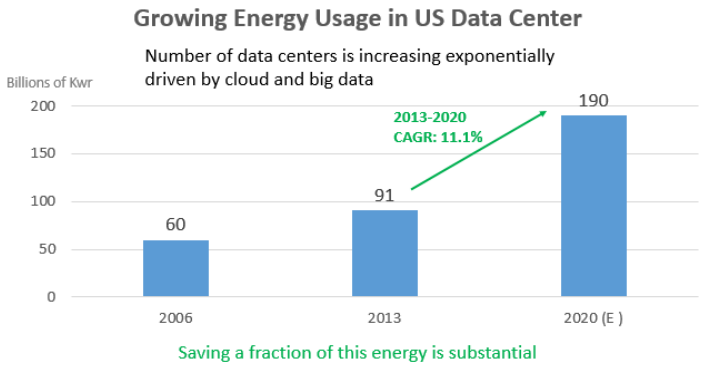

Figure 1: Growing Energy Use in Data Centers in the U.S. (Source: Google, citing EPRI)

Comparison of Two-Stage Power Conversion Modules

Two-stage solutions use 48V-to-12V modules to convert high voltage power input to 12V for existing IT gears (Figure 2). This solution could provide best TCO with quick deployment compared with the 48V to PoL solution for leveraging existing IT gears and avoid the noise coupling SI issue.

The biggest concern of the two-stage solution is power conversion efficiency. This chapter introduces the common two-stage power conversion modules and explains how the technology with SWC-regulated solution addresses the issues of power efficiency and cost.

Figure 2: 48V-to-12V Two-Stage Power Conversion Architecture

Two-stage 48V solution using 1/4 Power Brick

The solution with 48V PSUs and 1/4 Power Brick (Figure 3) is straightforward to implement 48V system. It can provide minimum distribution losses between the PSU and Brick inputs. However, the overall power efficiency could be worse than using traditional 12V PSUs due to the inefficient power brick module.

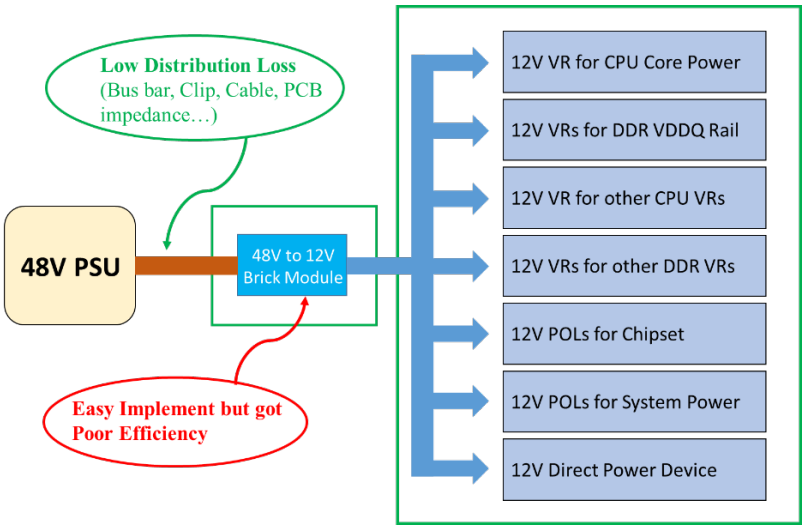

Figure 3: Two-stage 48V system with 1/4 Power Brick

The two-stage 48V solution using SWC - non regulated system

The two-stage 48V with SWC - non regulated solution provides better power efficiency compared to 1/4 power brick. However, since it is unregulated, the voltage output of SWC solution are dynamic and dependent on the voltage input. An additional 48V-to-12V power brick module is usually required for components demanding stable 12V power input (Figure 4). Although the power efficiency is elevated due to most of the power is consumed through SWC, there is room to improve both system power efficiency and cost for the additional module and PCB layout.

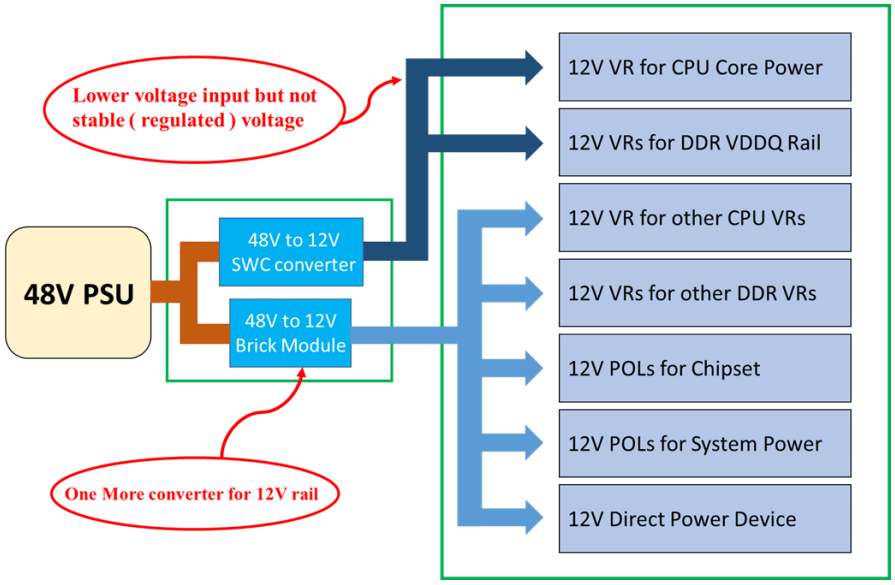

Figure 4: The two-stage 48V with SWC-non regulated system

The two-stage 48V solution with SWC- regulated system

The two-stage 48V solution with SWC-regulated system is first implemented and announced by Wiwynn and Renesas during OCP US Summit 2018. Renesas' regulated SWC converter provides a higher efficiency and cost-effective regulated output voltage to support a wide input supply range (40V to 60V) in the rack. Since it provides stabilized Vout at 12V, only one 48V-to-12V SWC regulated converter module is required (Figure 5).

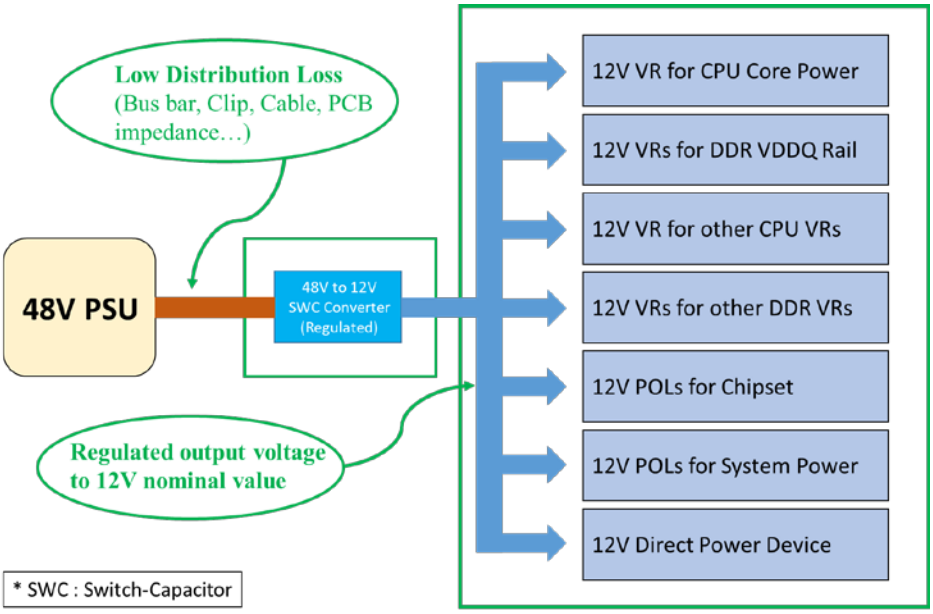

Figure 5: The two-stage 48V with SWC-regulated system

As shown in Figure 6, the SWC architecture is superior to traditional power brick solution. In addition, its ability to achieve ~ 98% efficiency across a wide load range translates to excellent efficiency in a variety of applications and easily outperforms traditional brick solution.

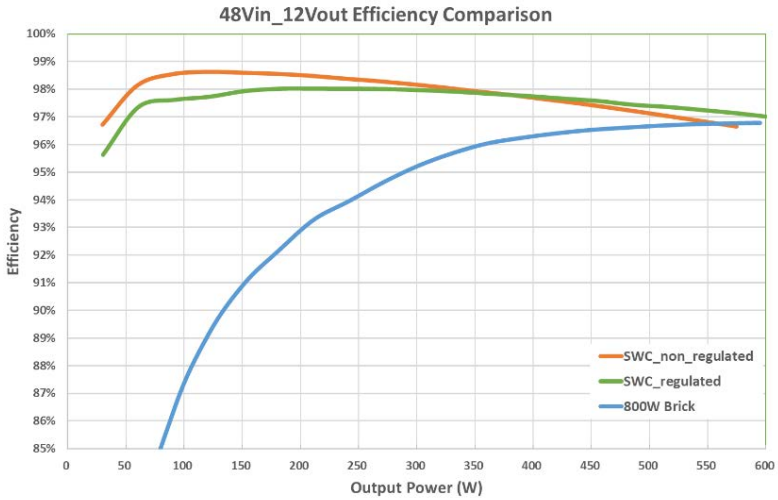

Figure 6. Efficiency Comparison with 800W Brick

From the system power efficiency (Table 1), the 48V two-stage solution with SWC-regulated also beats both traditional power brick and existing 12V system.

Table 1: Total System Efficiency Comparison

	PSU Eff	DC to Load Efficiency				Total System Efficiency	
		DC input to 12V rail	CPU Core VR	DDR VR	Other POLs	DC_IN	AC_input
12V system	94%	100.0%	95.00%	93%	92%	94.16%	88.51%
48V with Direct POLs (CPU core Power only)	96%	97.0%	93.00%	93%	92%	91.91%	88.23%
48V 2 stage with Brick/converter	96%	97.0%	95.00%	93%	92%	91.34%	87.69%
48V_2stage with Switch Cap converter	96%	98.5%	95.00%	93%	92%	92.70%	**89.04%**

*Assumed utilization rate: 68% for CPU core power, 12% for DDR, 20% for others

Implementation of Two-Stage 48V with SWC- Regulated Solution

The proposed two-stage 48V with SWC-regulated solution can be implemented to existing IT gears by simply adding a power delivery board (PDB) with 48V-to-12 SWC-regulated.

Wiwynn has turned the 2OU3N high density OCP 12V server (SV7220G3) into a 48V server with a small PDB connected right after the 48V power supply (Figure 7). The only differences between the original 12V and the new 48V systems are the PDB and power input. There are no design changes on mother boards.

PDB occupies a small space and fits in the existing cubby so most of the IT gears can quickly adopt it. The original 2OU server cubby and rack mechanical design are intact as shown in Figure 8 and Figure 9. Data centers can therefore expedite 48V adoption and enjoy high power efficiency with better TCO by maximizing utilization of existing IT gears.

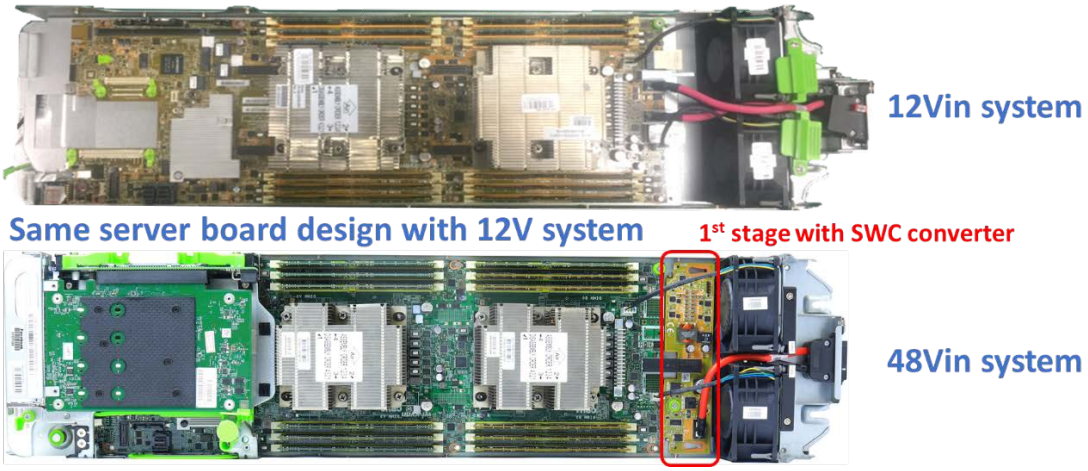

Figure 7: Original 12V server board (above) and
48V server board with SWC-regulated solution (below)

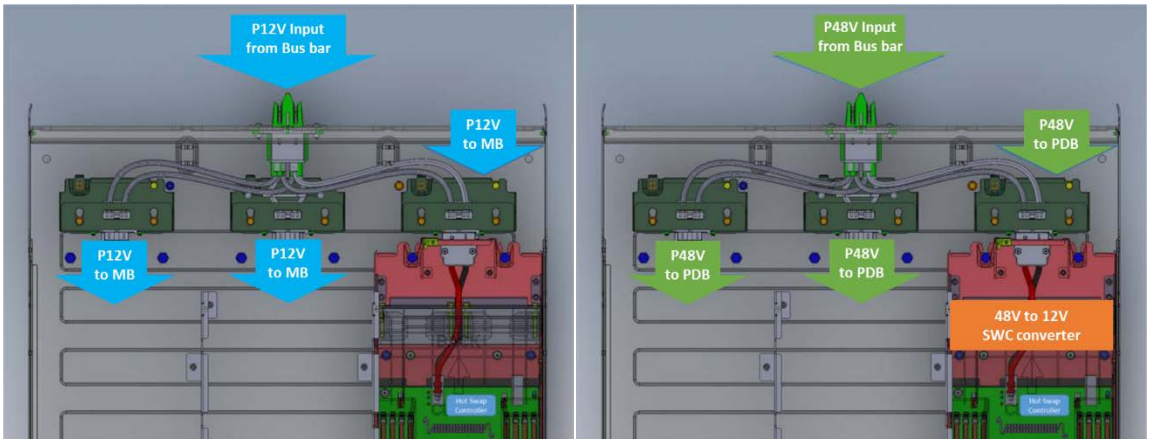

Figure 8: Original 12V server board (left) and
48V server board with SWC-regulated solution (right)

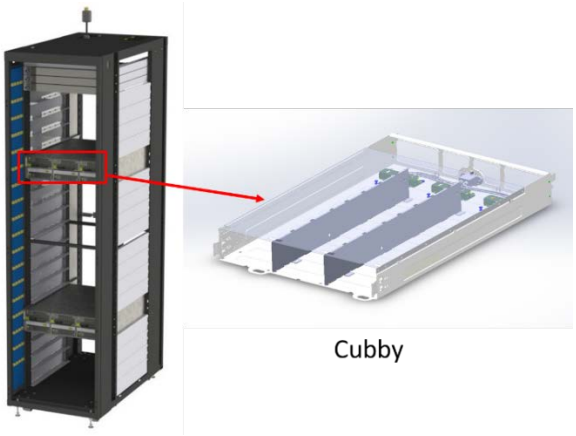

Figure 9: 48V two-stage Solution Implementation in existing OCP Rack

Performance Comparison of Different Power Distribution Systems

To verify the performance of the proposed two-stage 48V system (regulated), we compared the power efficiencies of “The traditional 12V system”, “The two-stage 48V system with 1/4 Power Brick” and “The two-stage 48V with SWC-regulated system”.

System function blocks:

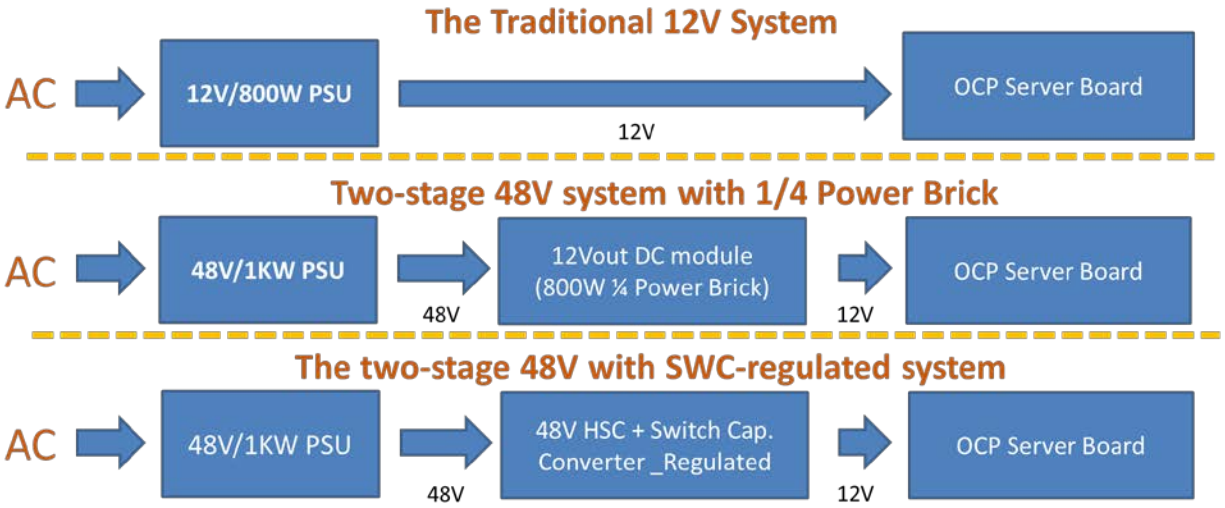

Figure 10: Function blocks of “The traditional 12V system”, “The two-stage 48V system with 1/4 power brick” and “The two-stage 48V with SWC-regulated system”

System Configuration:

We used the same configuration setting for these tested systemsas follows:

- CPU - Intel® Xeon® Gold 6139 CPU @2.30 GHz 135W
- DDR - HMA82GR7AFR8N-TF/UH/VK 16GB 2Gx721Gx8(H5AN8G8NAFR)
- Power meter - WT310E/YOKOGAWA

Test tool and conditions:

The Intel Performance Tuning Utility (PTU) is utilized in the test. We set two test scenarios for CPU and DDR load running at 50% and 100%.

The total power input results are recorded after the systems achieve thermal balance (around 30 minutes after the system burn-in).

Test summary:

From the test result (Table 2), we can see that even with one more stage power conversion, the power efficiency of the proposed two-stage 48V SWC-regulated system can still beat the traditional 12V system in both 50% and 100% system loadings.

- CPU and DDR running at 50%:
  The two-stage 48V SWC-regulated system enjoys 2.55W less power input (276.84W-274.29W=2.55W) compared with the traditional 12V system.
- CPU and DDR running at 100%:
  The two-stage 48V SWC-regulated system enjoys 3.28W less power input (409.91W-406.63W=3.28W) compared with the traditional 12V system.

Model / Load	**AC Input power**		
	OCP Server board with **The traditional 12V system**	OCP Server board with **Two-stage 48V system with 1/4 power brick**	OCP Server board with **Two-stage 48V system with SWC-regulated system**
50%	276.84W	283.1W	274.29W
100%	409.91W	414.5W	406.63W

Table 2: 12V/48V system input power consumption comparison

With the proven high power efficiency and the flexible PDB design, the two-stage 48V with SWC-regulated solution can expedite 48V adoption in scale rapidly and provide data center with better TCO.

Conclusion

The low power loss and high-efficiency 48V solution have been proven compelling in the data center market and converting systems. The two-stage 48V SWC-regulated architecture introduced in this whitepaper excels existing 48V solutions in the marketplace considering the power efficiency, cost and design complexity.

It not only provides 16x power distribution loss reduction from 12V system, but also delivers high power efficiency that outperforms other 48V-to-12V two-stage power conversion modules in the market.

The single module two-stage 48V SWC-regulated solution saves PCB layout space and reduces noise coupling risk by avoiding 48V rail on the server board or complex dual-module design used by non-regulated two-stage SWC solution.

Easy implementation for existing IT systems makes the two-stage 48V SWC-regulated architecture even more phenomenal. Wiwynn has successfully implemented the proposed solution, a PDB with 48V-to-12 SWC-regulated, on a high-density 2OU3N OCP 12V server system without design changes on the mother board, the cubby and the rack.

The space required for PDB is small and can be designed to fit in the existing cubby, data centers can leverage the breakthrough solution to accelerate the adoption of 48V technology, reduce investment in the development stage and enjoy high power efficiency with better TCO.

The two-stage 48V SWC-regulated architecture, to this point, is proven as the most efficient and cost-effective solution for data center operators to rebuild their power delivery system to enable high power and low PUE infrastructure with the best TCO. In the future, Wiwynn will continuously work on advanced SWC solution for efficiency improvement and power density enhancement to address the fast growing demand of compute-intensive and high power computing.

Reference

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- Demand Response in Data Centers- Jay Madden, Mukesh Khattar, Henry Wong, Chris Battista
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- SWC Enables Platform Wide 48V Conversion—Renesas
- Energy Use in Data Centers in the U.S., https://www.apec-conf.org/Portals/0/APEC%202017%20Files/Plenary/APEC%20Plenary%20Google.pdf?ver=2017-04-24-091315-930&timestamp=1495563027516

To Learn More

For further information, please refer to the following sites:

- PR: Wiwynn® Demonstrates Best-in-Class Two-Stage 48V Solution at OCP US Summit https://www.businesswire.com/news/home/20180320005560/en/Wiwynn%C2%AE-Demonstrates-Best-in-Class-Two-Stage-48V-Solution-OCP

- OCP US Summit 2018 Engineering Workshop:
  Efficiency Improvement by two-stage 48V Solution
  https://www.youtube.com/watch?v=qNG9LNytwdA

- Whitepaper: 48V: An Improved Power Delivery System for Data Centers
  http://www.wiwynn.com/english/company/newsinfo/1038

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