Application Brief

Op Amps For Better Rack Power In Data Centers

Introduction

Recent advancements in artificial intelligence (AI) have created a massive demand for data centers. Data centers hold critical computing, storage, and networking hardware. The unprecedented energy demand from the growth in compute capacity has forced the industry to reconsider the way power is distributed to the rack servers in the data center. Architecture changes are pushing voltages from 54VDC (48V nominal) to 800VDC to deliver more than 100kW of power. Now, more than ever, proper metering of power distribution to rack servers is critical. Texas Instruments supports a variety of different current and voltage sensing amplifiers to support the latest rack server power architecture. This article focuses on how next generation op amps are enabling the latest technology.

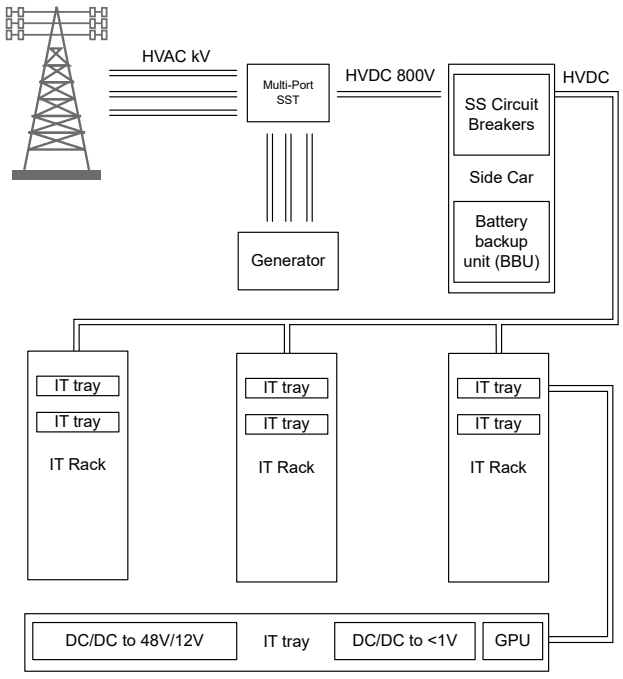


Figure 1. Next Generation Rack Server Power Architecture

Increasing Board Density

As data centers aim to maximize the limited rack server space for computing capacity, power management functions need to occupy an increasingly smaller space. Highly dense boards are enabled today by recent small package innovations in power management and other analog signal chain ICs, like operational amplifiers. The OPAx986 family of precision op amps, for example, are available in both DRL (1.5mm × 1.5mm single channel SOT) and DSG (2mm × 2mm dual channel WSON) packages. The OPAx986 and the OPAx486 op amps constitute the smallest high voltage, precision amplifiers ever. Manufacturers can now count on precision metering without sacrificing valuable board space.

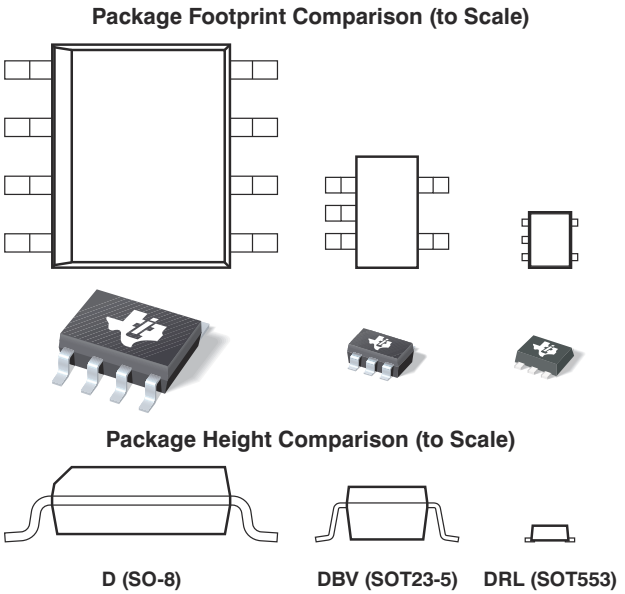


Figure 2. OPAx986 Leaded Package Comparison

Increasing Voltage

While most computing chips operate on 1V power supplies, several intermediate voltages exist between the final compute voltage and the 800VDC rack server distribution voltage. Some intermediate voltages include 12VDC to power auxiliary and telemetry ICs, and 54VDC for the current generation systems. The new family of OPAx986 and OPAx486 op amps can be powered with up to 48V and as little as 4.5V to perform telemetry and metering functions. Higher voltage capability enables accurate high-side current and voltage sensing and improves robustness against unexpected voltage surges. High-side current sensing

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enables short-to-ground detection and avoids any ground disturbance from the sensing circuitry.

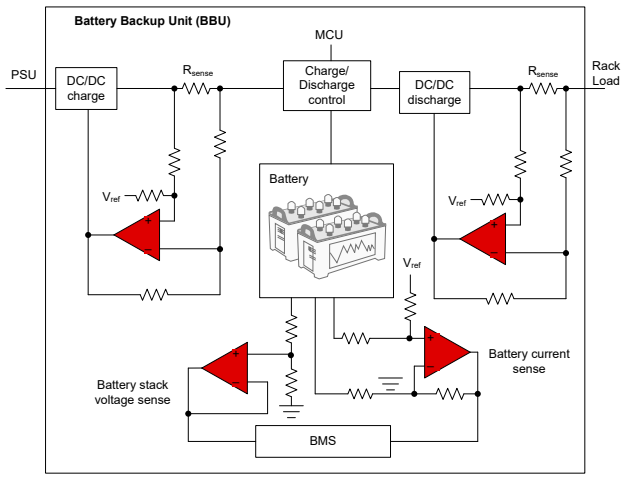


Figure 3. High Side Current Sensing

The family of 85V op amps from Texas Instruments, including OPAx591, support high-side current sensing directly on the 54VDC rail. These amplifiers offer a 93V absolute maximum voltage rating to enable designs that support relevant Open Compute Project (OCP) ORv3 high voltage requirements.

Higher Accuracy

As power requirements in a data center increase, so do the requirements for safety, reliability, and accuracy. Maintaining accuracy across a wide variety of operating conditions, like temperature and power supply variations, enables safer, more reliable systems. In most cases these systems require carefully designed ICs. The OPAx986 for example, is designed with e-Trim™, a proprietary post packaging offset and temperature drift correction circuitry, to achieve a very high level of accuracy across a variety of operating conditions. The OPAx486, conversely, is designed with Zero-Drift, a self-calibrating architecture, to achieve near zero offset temperature drift. Given that offset is one of the major sources of error in current and voltage measurement, keeping offset low is critical to maintaining high accuracy measurements. When very high common-mode voltage support is required, the OPAx591 provides a high operating voltage up to 85V and is laser trimmed to achieve high precision across different operating conditions.

Better Regulation

Power supplies are required to provide a stable voltage or current across a wide variety of load conditions. A carefully designed control loop and compensation is critical to maintaining a reliable power supply. The OPAx986 makes an excellent error amplifier and enables different compensation implementations. To avoid excessive droop and ripple due to sudden load changes and transients, the control loop must be able to respond quickly to any changes. The error amplifier must therefore have enough bandwidth to support the desired compensation and control loop speed. Intermediate 48V and 12V power rails often require control loop bandwidths in the 10s of kHz. Modern GPU requirements are pushing point-of-load requirements to 100kHz and beyond as the power supply needs to respond to massive current demands.

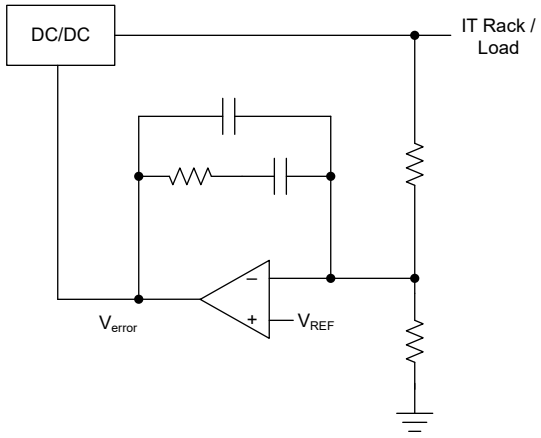


Figure 4. Type II Compensation

Tighter Budgets

With rack server production ramping with data center demand, manufacturers are challenged to keep up with increasingly demanding performance as budgets are squeezed by competition. The OPAx986 and OPAx486 provide exceptional value for cost sensitive systems. These amplifiers are designed with both cost and performance in mind and are manufactured with the latest 300mm wafer technology from Texas Instruments for expanded capacity.

Summary

Technology moves fast and keeping up with rapidly changing requirements is critical for server power manufacturers. Texas Instruments aims to provide cutting-edge products that enable growing AI infrastructure. The new family of e-trim™ op amps, including OPAx986 and OPAx985 and the new family of Zero-Drift op amps including OPAx488 and OPAx486, provide the size, performance, cost and supply chain leadership required to support systems today and into the future.

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Table 1. Recommended Products

Devices	Power Supply	Input Offset Voltage	Bandwidth	Packages
OPAx986	4.5V to 48V	50µV	14MHz	Single Channel: D (SOIC-8), DBV (SOT23-5), DRL (SOT-5)
				Dual Channel: D (SOIC-8), DGK (VSSOP-8), DSG (WSON-8)
				Quad Channel: D (SOIC-14), PW (TSSOP, 14)
OPAx985	4.5V to 48V	50µV	5.6MHz	Single Channel: D (SOIC-8), DBV (SOT23-5), DRL (SOT-5)
				Dual Channel: D (SOIC-8), DGK (VSSOP-8), DSG (WSON-8)
				Quad Channel: D (SOIC-14), PW (TSSOP, 14)
OPAx488	4.5V to 48V	7.5µV	14MHz	Single Channel: D (SOIC-8), DBV (SOT23-5), DRL (SOT-5)
				Dual Channel: D (SOIC-8), DGK (VSSOP-8), DSG (WSON-8)
				Quad Channel: D (SOIC-14), PW (TSSOP, 14)
OPAx486	4.5V to 48V	5µV	5.6MHz	Single Channel: D (SOIC-8), DBV (SOT23-5), DRL (SOT-5)
				Dual Channel: D (SOIC-8), DGK (VSSOP-8), DSG (WSON-8)
				Quad Channel: D (SOIC-14), PW (TSSOP, 14)
OPAx591	8V to 85V	225µV	2.5MHz	Single channel: DBV (SOT23-5)
				Dual channel: D (SOIC-8), DGK (VSSOP,8)
OPAx596	8V to 85V	1mV	2.5MHz	Single channel: DBV (SOT23-5)
				Dual channel: D (SOIC-8), DGK (VSSOP,8)

References and Resources

1. Open Compute Project (2024). *8V Onboard Power Solution Requirements*.
2. Power Electronics News (2025). *A Look into the Industry's First Commercially Available Multiport SST*.
3. Texas Instruments (2025). *Data Centers Evolve to Meet AI's Massive Power Needs*.
4. Texas Instruments (2018). *OPAx170 36-V, Single-Supply, SOT553, Low-Power Operational Amplifiers Value Line Series*.
5. Texas Instruments (2014). *Demystifying Type II and Type III Compensators Using Op-Amp and OTA for DC/DC Converters*.

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