Application Brief

Achieving High-Performance Isolated Current and Voltage Sensing in Server PSUs

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The growing demand for cloud-based technology among internet content providers, communications service providers, and many consumer and business entities are driving a strong demand for data centers. The power-supply distribution networks in these data center servers, starting from the front-end power-factor correction (PFC) stage to the DC-DC stages, are required to meet high-efficiency and power density standards.

A certification standard, called 80 PLUS, developed by Electric Power Research (EPRI) in collaboration with Ecos consulting, promotes efficient energy use in data center server power-supply units (PSU). The server PSUs can receive one of the many 80 Plus certifications such as Gold, Platinum, and so forth, based on achievable energy efficiency at rated load and power factor (PF) levels.

Understanding Titanium Standard Requirements

The 80 Plus Titanium standard efficiency, PF and current total harmonic distortion (iTHD) requirements are shown in Table 1, Table 2, and Table 3 respectively.

Table 1. Titanium Standard Efficiency Requirements

	115-V Internal Non-redundant				230-V Internal Redundant				230-V EU Internal Non-redundant			
	Rated Load											
	10%	20%	50%	100%	10%	20%	50%	100%	10%	20%	50%	100%
Titanium Efficiency	90%	92%	94%	90%	90%	94%	96%	91%	90%	94%	96%	94%

Table 2. 80 Plus Titanium Standard PF Requirements

Output Power	10%	20%	50%	100%
Power Factor	> 0.90	> 0.96	> 0.98	> 0.99

Table 3. 80 Plus Titanium Standard iTHD Requirements

Output Power	> 5% and ≤ 10%	> 10% and < 20%	≥ 20%	≥ 40%	≥ 50%
iTHD	< 20%	< 15%	< 10%	≤ 8%	≤ 5%

High-Efficiency Server PSU Implementation

Figure 1 shows such an implementation of a server power supply with PFC and DC-DC stages. A non-isolated PFC stage ensures the rectified line current follows the rectified line voltage. This front-end PFC stage creates an intermediate DC bus with a relatively large ripple. An isolated DC-DC stage then provides galvanic isolation and a well-regulated output voltage with minimum output current ripple.

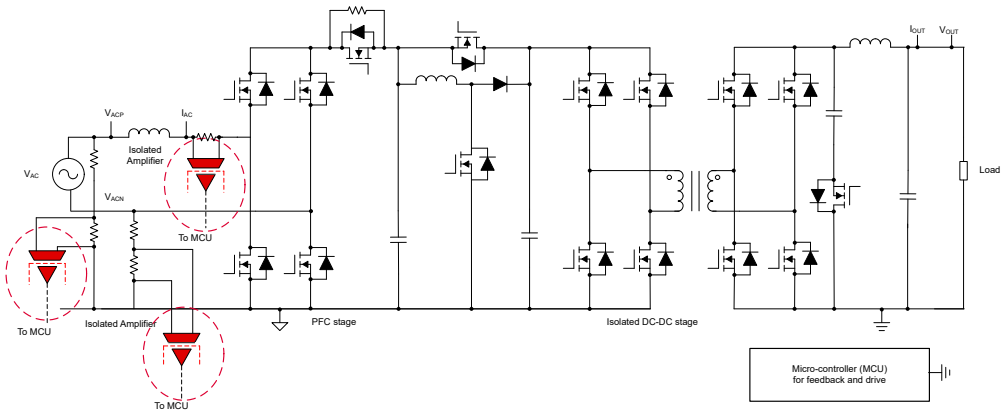

Figure 1. Implementation of a Server Power Supply With PFC and DC-DC Stages

The power factor for maximum efficiency should be close to unity. An efficient PFC is done by a single-phase totem pole bridgeless topology with a voltage and a current control feedback loop. The voltage feedback loop is used to regulate the PFC bus voltage to a preselected value and the current feedback loop regulate the total average inductor current. The current loop requires high measurement accuracy and high bandwidth to meet the Titanium standard efficiency, PF, and iTHD requirements. Depending on the architecture and the location of MCU, the current and voltage sensing feedback path might or might not need to be isolated.

Isolated High-Performance Current and Voltage Sensing in Server PSUs

Shunt-based current measurements are the preferred option to achieve the high accuracy levels and bandwidth in the current feedback loop. Shunt-based solutions offer higher accuracy, lower temperature drift, and higher bandwidth than open-loop Hall-based current sensors. Closed-loop Hall sensor modules could be an alternative, but they are very expensive compared to shunt-based solutions to reach the required performance.

Shunt resistors paired with reinforced isolated amplifiers such as the AMC3301 (±250-mV input range) or AMC3302 (±50-mV input range), that can operate using a single supply and offer bandwidth up to 300 kHz, provide a simple, easy-to-implement, solution for accurate shunt-based isolated current sensing. These products include a fully-integrated DC-DC converter that eliminates the need for supply on the current measurement side. For voltage measurements, a resistor divider network followed by reinforced isolated amplifiers such as AMC3330 (±1-V input range) allows very accurate isolated voltage sensing. Figure 2 and Figure 3 show the block diagrams of AMC3301 and AMC3330 respectively.

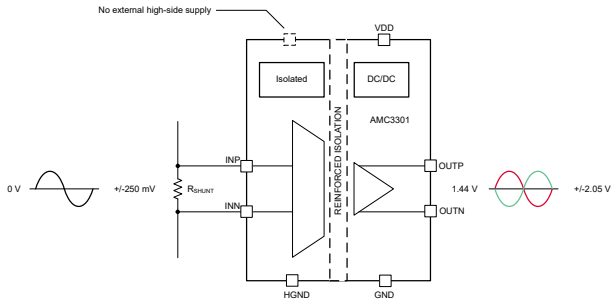

Figure 2. AMC3301 Block Diagram

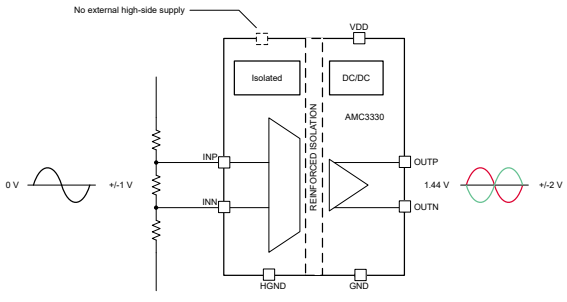

Figure 3. AMC3330 Block Diagram

Conclusion

As the trend of server PSU manufacturers striving to achieve Titanium standard certifications increases, the AMC33xx family of products, provide a high-performance, cost-optimized, easy-to-implement solution for isolated current and voltage sensing.

Resources

- Texas Instruments, *Isolated amplifiers and modulators* TI training and videos
- Texas Instruments, *Comparing Isolated Amplifiers and Isolated Modulators* white paper
- Texas Instruments, *Comparing shunt- and Hall-based current-sensing solutions in onboard chargers and DC/DC converters* white paper
- Texas Instruments, *Accuracy Comparison of Isolated Shunt and Closed-Loop Current Sensing* application brief

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