80 PLUS® Ruby – The New Efficiency Target for Data Centers

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The 80 PLUS® efficiency standards have been updated, with Ruby surpassing Titanium as the most stringent target.

The 80 PLUS standard has now entered its third decade, and the 80% efficiency requirement is a dim and distant memory. However, the announcement of the new 'Ruby' level within the 80 PLUS framework is the first step forward in 14 years and will be critical in reducing data center power consumption.

In this article we will look at the new standard and the technologies that are needed to achieve it.

Data center power consumption

Artificial Intelligence (AI) is expanding at a blistering pace and notwithstanding the huge benefits of this technology, it is a significant user of energy, especially during the machine learning (ML) phase that is needed to train the models on which AI is based.

To cope with demand the number of data centers deployed globally has approximately doubled in the last decade, to 7,000. By 2026, data centers globally are expected to consume 1,000 TWh, more than double the 2022 figure (460 TWh) and a level that the US is likely to reach on its own by 2030.

Growth is not solely constrained to the US. Sweden's data center usage is likely to double by 2030 and double again by 2040. The situation in the UK is similar, with a five-fold growth predicted within the next decade.

Globally, the energy consumed by data centers accounts for 2% of all energy consumed. In the US this figure is higher (3%) due to the number of data centers deployed. However, by 2030, it is expected that data centers will account for 8% of global electricity usage, with the growth wholly driven by the demands of AI.

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Clearly, the availability of electrical energy is critical for this sector to grow. To address this, data center operators are considering investments in renewables or even small-scale nuclear facilities to power their AI. However, no matter where the energy originates, there can be no argument that it must be used as efficiently as possible.

Standards driving efficiency

Since 2004, the 80 PLUS framework has provided an industry-wide benchmark for power supply unit (PSU) efficiency, albeit on a voluntary basis. In the past, PSU manufacturers had often quoted a single figure for efficiency which could mask poor performance, resulting in inefficient operation. The 80 PLUS specification addressed this by requiring PSUs in computers and servers to demonstrate at least 80% energy efficiency at 10%, 20%, 50%, and 100% of rated load, along with a true power factor of at least 0.90.

Additionally, Ruby added a requirement for 90% efficiency at 5% load and extended the PFC requirement across 5% - 100% load for its 277 V and 480 V internal redundant supply frameworks. It has also increased the Power Factor to 0.96 from 20% to full load for these.

Over time, the framework evolved to include more stringent levels for higher performance power supplies (Bronze, Silver, Gold, Platinum), and in 2011 this culminated in the 'Titanium' standard being announced. Not only did this increase the required efficiency at higher loads to 96%, it also added a requirement for 90% efficiency at just 10% load and moved the PFC requirement to 20% load.

80 PLUS Certification	277V / 480V Internal Redundant				
% of Rated Load	5%	10%	20%	50%	100%
80 PLUS					
80 PLUS Bronze		80%	82%	85% PFC ≥ 0.90	82%
80 PLUS Silver		82%	85%	89% PFC ≥ 0.90	85%
80 PLUS Gold		85%	88%	92% PFC ≥ 0.90	88%
80 PLUS Platinum		88%	90%	94% PFC ≥ 0.95	91%
80 PLUS Titanium		90%	94% PFC ≥ 0.95	96%	91%
80 PLUS Ruby	90% PFC ≥ 0.90	91% PFC ≥ 0.90	95% PFC ≥ 0.96	96.5% PFC ≥ 0.96	92% PFC ≥ 0.96

Figure 1: 80 PLUS requirements for 277 V / 480 V internal redundant PSUs (Source: CLEAResult)

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Recognizing that efficiency is impacted the local grid voltage level, as well as whether the PSU has a single- or multi-phase input, or redundant operation, further frameworks were issued to address these factors.

Following an endorsement by the Green Grid consortium, in January 2025 CLEAResult (the administrating body of 80 PLUS) announced a further level – 80 PLUS Ruby. As the first data center badge criteria update in 14 years, this raises the stakes significantly.

Compared to Titanium, Ruby increases the efficiency requirement at all power levels, with it increasing for 20% loads from 94% to 95%, and for 50% loads from 96% to 96.5%. While at first glance, these 1- and half-point increases may seem to be a small increment when expressed as efficiencies, they represent loss reductions of 16.7% and 12.5% respectively.

To put these in context, as data center electricity consumption will reach 1,000 TWh globally by next year every half point improvement in PSU efficiency saves 5 TWh, which equates to a little over 2 million tons of CO_2 based on the US's standard electricity source mix (source EPA eGrid 2023 data tables (1) (2)).

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Technologies needed to achieve 80 PLUS Ruby

When designing power solutions to meet stringent targets such as those set by 80 PLUS, designers must consider what topologies are appropriate for each conversion stage as well as the materials used within the primary power switches.

Designers are looking to wide-bandgap (WBG) materials such as silicon carbide (SiC) and gallium nitride (GaN) to enable highest power densities and efficiencies.

In addition, server PSUs must comply with industry standards for compatibility and interoperability such as the Open Compute Project (OCP) Data Center – Modular Hardware System (DC-MHS) specifications that standardize interfaces and form factors for equipment targeting data centers.

M-CRPS (Common Redundant Power Supply) is an OCP standard that standardizes 1U-high internal PSUs, as is the form factor for ORv3 power shelves that incorporate six PSUs per shelf. While M-CRPS PSUs can have a 12 V output, 54 V is now preferred due to reduced currents. Power shelves tend to standardize on 48 V for the same reason.

Given the need for efficiency in a constrained space, the LLC converter is becoming essential in data center / server PSU design, especially when built upon WBG technologies.

LLC converter performance can be enhanced by the integration of planar transformer technology that embed flat windings directly into PCB layers to improve thermal performance, reduce leakage inductance, and enhance power density.

When combined with high-frequency GaN devices, the planar transformer advantage is seen more clearly as they have a low voltage-second product that eliminates core saturation, thereby reducing overall losses.

Using this topology and approach, Navitas has designed a single output 54 V CRPS, using high-power GaNSafe ICs and Gen3-Fast SiC MOSFETS with an output power rating of 4.5 kW, and achieving an industry-leading power density of 137 W/in^3.

With this design, a wirewound transformer could handle the 83 A current. However, to meet the size constraints of the OCP standards, the switching frequency must be (at least) 300 kHz to reduce the size of the output capacitors and magnetics. And this means silicon is no longer suitable for OCP-compliant designs as this is beyond the level at which silicon can function.

At this point it should be noted that, while designing with GaN devices is quite similar to silicon, particular care has to be paid to the gate drive as the thresholds are lower and voltage spikes or ringing can reduce device reliability. Navitas' GaNSafe ICs used in this reference design include control, drive, and protection, eliminating the risk of damage.

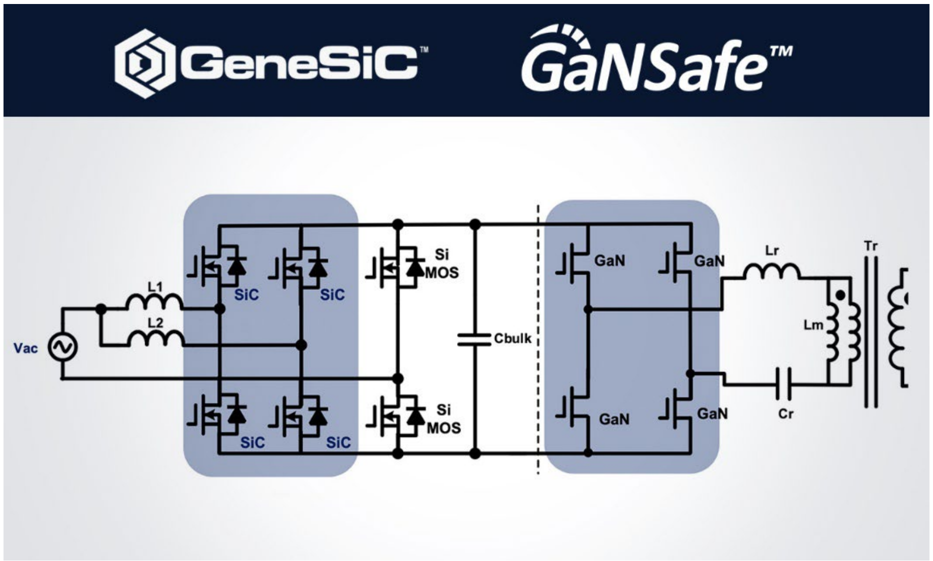

Figure 2: Navitas' 4.5 kW, 54 V CRPS achieves 137 W/in^3 using SiC and GaN devices

In the reference design, a bridgeless interleaved totem-pole PFC stage is used as there are far fewer losses than with a conventional bridge rectifier. The design is based upon Navitas Gen-3 Fast SiC MOSFETs as they have very low reverse recovery and switching losses. Therefore, the PFC stage can operate in continuous conduction mode with loss levels that simply could not be achieved with silicon.

Navitas' GeneSiC™ devices are based upon a 'trench-assisted planar' structure that enhances performance through an $R_{DS(ON)}$ that is 20% lower than competing devices, as well as being more stable over extended temperature ranges.

As a result, the reference design delivers over 97% efficiency at 50% load.

Is the industry ready for Ruby?

The leap from 80 PLUS Titanium to Ruby is significant as it extends the requirements to 5% load and broadens the load levels for PFC compliance. As we've touched on, this single-point improvement at 50% load may seem small, this represents a 16.7% reduction in losses.

Figure 3: Navitas' 8.5 kW PSU achieves 98% efficiency and complies with OCP and ORv3 guidelines.

In late 2024, Navitas launched an 8.5 kW AI data center PSU design. This reference design is OCP and ORv3 compliant and achieves this through the use of GaNSafe and Gen-3 Fast SiC MOSFETs as described earlier and achieves an overall efficiency is 98%.

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