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GaN devices boost the development of CRPS power supplies

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Background

- With the rapid development of advanced information technologies such as Artificial Intelligence(AI), Big Data, 5G and the Internet of Things(IoT), higher technical requirements for energy efficiency, stability and reliability have been put forward for the power systems of data centers, intelligent computing centers, telecommunication networks and data servers, to ensure the uninterrupted operation of data processing and network services.
- Especially as AI technologies develop rapidly, the increase in AI model parameters and data volume is causing computational power demands to double. This growth directly leads to a significant rise in energy consumption.
- This drives the need for high-density, high-efficiency, and high-reliability power systems to meet the massive data processing and storage demands.

Year	Qty of std rack* (K)	Total energy consumption (billion kilowatt-hrs)	Avg energy consumption per rack (kW)	Annual growth (racks)
2019	2,270	1,050	6.2	+15%
2020	2,890	1,240	6.5	+27%
2021	4,000	1,550	7.1	+38%
2022	5,200	1,800	7.5	+30%
2023	6,500	2,100	8.0	+25%

Source: Data Center White Paper from China Academy of Information and Communications Technology
Note: Std Rack refers to a 2.5kW rack (equivalent conversion)*

"The end of AI is computing power, and the end of computing power is electricity."

What’ s CRPS

- CRPS power supplies (Common Redundant Power Supply) are power solutions specifically designed for these applications. With their high power density, high energy efficiency, redundant design, and hot-swap capabilities, CRPS power supplies are becoming a hot topic in the development of power supply technologies.
- CRPS power supplies are available in various power ratings, including 550W, 800W, 1300W, 1600W, 2000W, 2400W, 2700W, 3000W, and 3200W. According to the efficiency certification standard, they are categorized into Bronze, Silver, Gold, Platinum, and Titanium 80 Plus efficiency levels, each reflecting a distinct energy efficiency.

Core Function	Key Features
Higher Efficiency	Offers a power range from 550W to 3200W and feature market-leading power density, making them suitable for applications with high power demands and space limitations. These power supplies typically come with Platinum or Titanium 80 Plus certification, indicating efficiency levels exceeding 94%
Redundant Power Supply	Supports N+1 or 2N redundant configurations, enabling seamless transfers during single power supply failures to ensure continuous equipment operation
Hot-Swap	Hot-swappable power module allows for replacement without downtime, minimizing system downtime (MTTR <1 minute) and the risk of data loss
Standardized design for Compatibility	Meets Intel's CRPS specifications (e.g., unified size and interface) to fit devices from various manufacturers, such as Huawei, Dell, and HPE servers, and satisfies international certification standards like CE, NRTL, TUV, CCC, and CB

Applications

Customer Needs

CRPS power supplies are crucial in modern IT infrastructure. As core components in data centers, cloud computing, and big data processing, they ensure systems run smoothly by providing reliable, efficient, and uninterrupted power. This supports high-performance computing environments and guarantees continuous data processing and network services.

01

Data Center

High power density and efficiency cut operating costs and energy use.

02

Enterprise Server

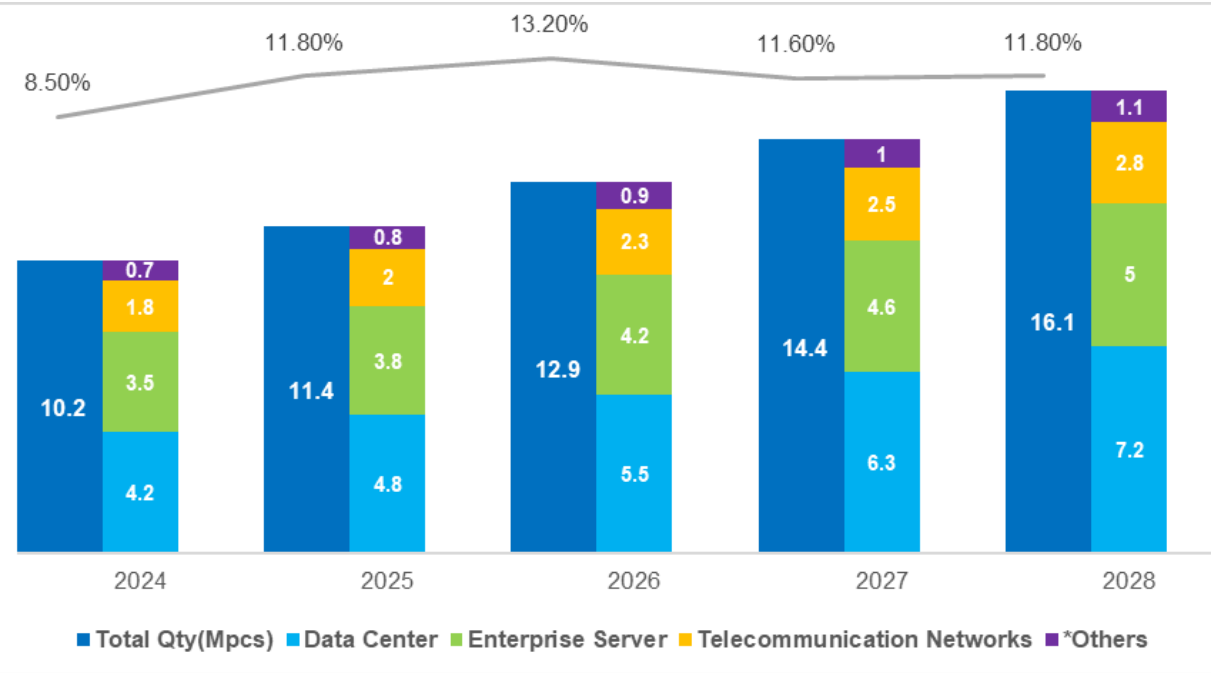
The power supply must be highly efficient, stable, and smartly managed

03

Telecommunication Networks

It requires a stable, long-term power supply to safeguard data

Market Trend



Source: IDC、Gartner、TrendForce
*Note: *others refer to niche market such as medical and military sector*

> Global demand is projected to reach 16.1 million units by 2028, with a CAGR of approximately 12%, driven mainly by data centers and enterprise servers.

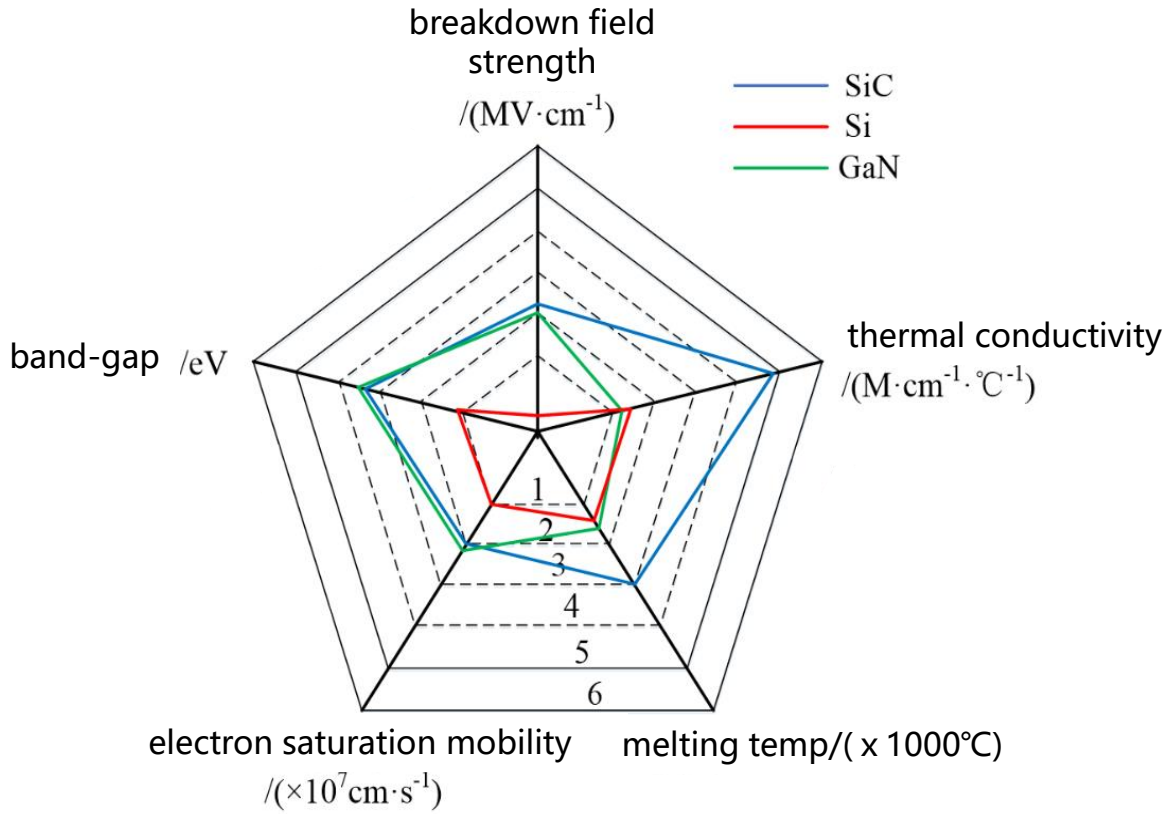
> Expansion in data centers, especially hyperscale ones like AWS and Microsoft Azure (accounting for over 60%), is boosting the demand for high-power CRPS (≥2000W).

> The accelerated deployment of 5G is increasing the demand for CRPS in telecom equipment, particularly at edge computing nodes such as Huawei and Ericsson base stations.

> Energy efficiency regulations, including the EU's CoC V9 standard mandating server power supplies to achieve a minimum efficiency of 96%, are driving the adoption of GaN/SiC CRPS technologies.

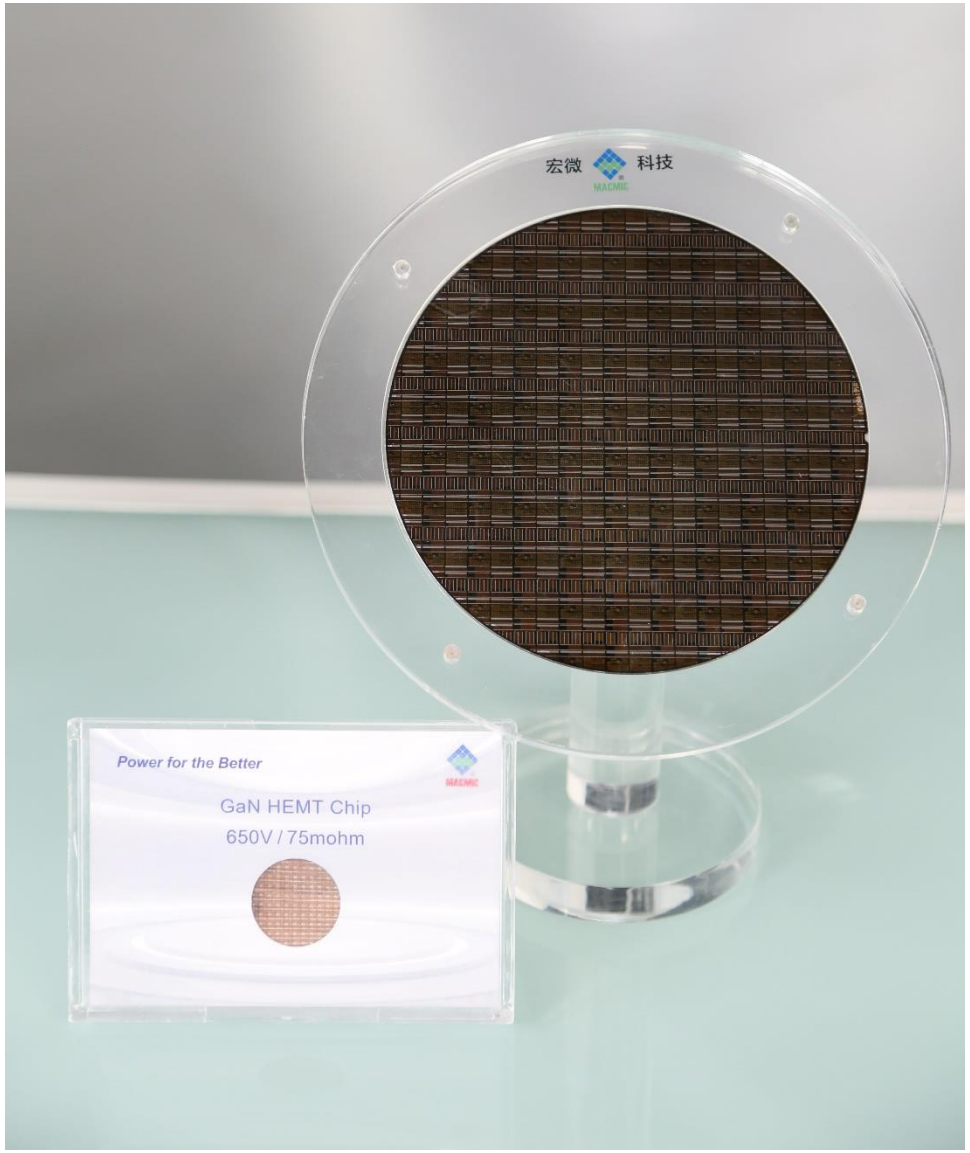
Opportunity of WBG

- The development of semiconductor science and technology shows that breakthroughs in new semiconductor materials and devices often lead to new technological revolutions and the emergence of new industries.
- The rapid rise of third-generation wide-bandgap semiconductor materials, represented by Silicon Carbide (SiC) and Gallium Nitride (GaN), has made them the preferred choice for the new generation of high-efficiency, high-voltage, and high-capacity power electronic devices.
- As a result, power semiconductor devices based on SiC and GaN exhibit far better performance in withstanding high voltage and switching speed compared to silicon-based devices. This makes them highly effective in promoting the development of power electronic systems towards higher efficiency, miniaturization, and lightweight designs, thereby enhancing the overall system performance and driving innovation in power electronics technology.



Pros Vs Cons

Index	Si Devices	SiC Devices	GaN Devices	Impact on CRPS Power Supplies
Voltage Resistance	Medium (<900V)	**Excellent (650V-1700V)**	Medium **(Best below 650V)**	SiC is suitable for high-voltage inputs (e.g., three-phase AC).
Switching Frequency	Low (<100kHz)	Medium (100-500kHz)	**Excellent (1-10MHz)**	GaN is ideal for high-frequency, small-volume designs.
Conduction Losses	Poor (Rdson surges at high temperatures)	**Excellent (Rdson stable with temperature)**	Medium (Better than Si at low voltages)	SiC offers higher efficiency in high-voltage, high-current scenarios.
Reverse Recovery	High Qrr	Low Qrr (1/10 of Si)	**No Qrr**	SiC/GaN are both suitable for high-frequency PFC.
Cost	**Excellent (Lowest)**	High (3-5x Si)	Medium (2-3x Si)	Si remains the preferred choice for low-cost solutions.
Thermal Management	Poor (<150°C)	**Excellent (>200°C)**	Medium (150-200°C)	SiC is suitable for high-temperature environments (e.g., outdoor cabinets).
Reliability	High	To be tested (Insufficient long-term data)	To be tested (Insufficient long-term data)	



MACMIC

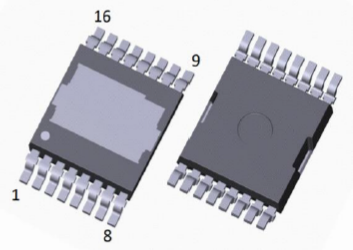
MM075H65L

650V 75mΩ GaN TOLT

April 2025 | Preliminary | RoHS Compliant

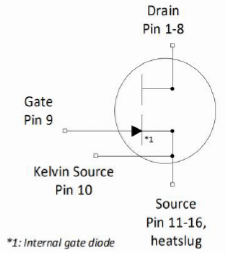
PRODUCT FEATURES

- ☐ Enhancement mode transistor-Normally off power switch
- ☐ Ultra high switching frequency
- ☐ No reverse-recovery charge
- ☐ Low gate charge, low output charge
- ☐ Qualified for industrial applications according to JEDEC Standards



APPLICATIONS

- ☐ AC-DC converters
- ☐ DC-DC converters
- ☐ DC-AC converters
- ☐ High density power conversion
- ☐ High efficiency power conversion



Maximum Ratings(T_C =25°C *unless otherwise specified*)

Symbol	Parameter/Test Conditions		Values	Unit
V_{DS}	Drain-source Voltage	V_{GS}=0V,T_{vj}=-55℃ to 150℃	650	V
V_{GS}	Gate-source Voltage（Continue）	T_{vj}=-55℃ to 150℃	-1.4/+7	V
$V_{GS,pulse}$	Gate-source Voltage（Pulse）	T_{vj}=-55℃ to 150℃; t_{PULSE}=50ns, f=100kHz; open drain	-20/+10	V
I_D	Continuous Drain Current	V_{GS}=6V,T_C=25℃,T_{vjmax}=150℃	24	A
$I_{D,pulse}$	Pulsed Drain Current	T_c=25℃; V_{GS}=6V; t_{PULSE}=10μs	32	A
P_D	Power Dissipation	Tc=25°C,limited by T_{vjmax}	138	W
T_{vj}, T_{stg}	Operating Junction and Storage Temperature		-55~150	℃
Weight			1.6	g

Challenges of GaN development

GaN HEMT Chip Design

Special field plate structures designed to optimize the electric field distribution, and thereby enhancing the breakdown voltage of the device. This novel field plate design and process development can modulate the electric field through the deposition of a metal thin film, achieving process simplification.

Integrated circuit design of gate driver

Building integrated gate driver circuits into GaN devices can enhance the transmission speed of the driver chip, reduce reverse recovery losses, protect the gate of the device, and optimize dead time.

Package design for high power density

Advanced stacked packaging enables the vertical interconnection of heat sinks and GaN devices through 3D structure to improve thermal diffusion and to optimize electric field modulation under ultra-high current injection and boosting long-term device reliability.

Overview

- As AI-powered servers and data centers continue to upgrade, CRPS power supplies have to evolve accordingly. They are trending toward ultra-high power capabilities, with outputs scaling from 550W and 800W to 1300W, 1600W, and 2000W, and are projected to reach 2700W or even 3200W in the coming five years.
- In future power supply designs, power devices are required to be smaller in size, yet deliver higher power outputs. Meanwhile, the surface cooling demands for power modules are increasing, driving a shift from air-cooled systems to liquid-cooled systems.
- The trend in power devices for CRPS power supplies indicates that GaN is progressively substituting Si-based devices, leveraging its efficiency benefits. It is supposed that by 2028, GaN may capture over 50% of the high-end market, while Si-based devices will still command a significant share of over 70% in the mid-to-low-end segment.
- GaN devices have significantly advanced CRPS power supply technology through multiple advantages such as enhancing power density, improving conversion efficiency, strengthening thermal management, and reducing system costs, providing more efficient and reliable power supply solutions for high-performance computing scenarios like data centers.
- As technology matures and economies of scale come into play, GaN is on track to become the mainstream choice for CRPS power supplies within the next five years.