

# 第三代半导体驱动超高功率密度 CRPS185 3200W钛金Plus 服务器电源设计

魏涛

纳微半导体

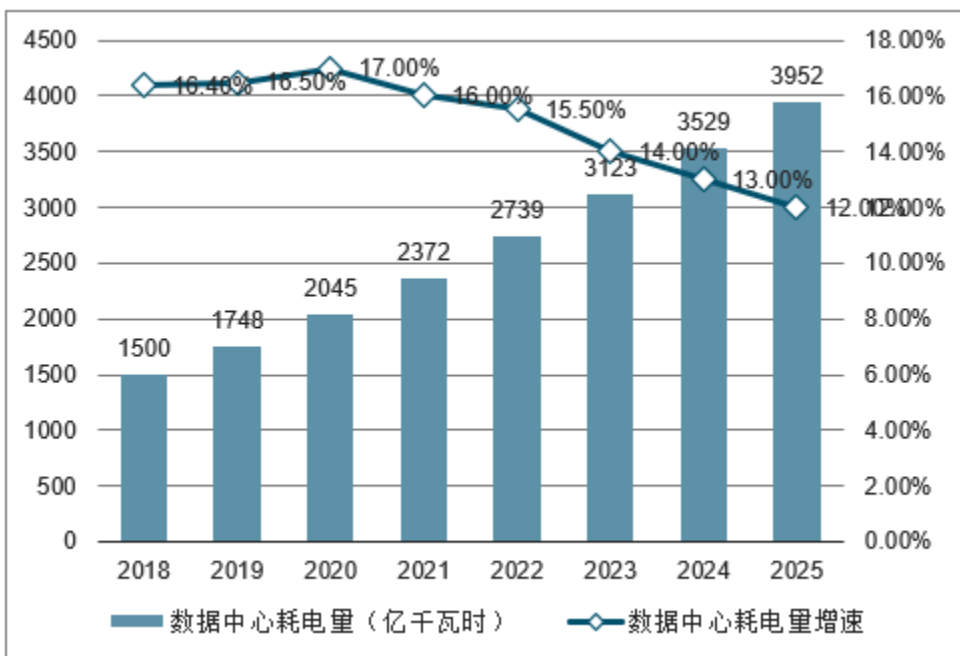
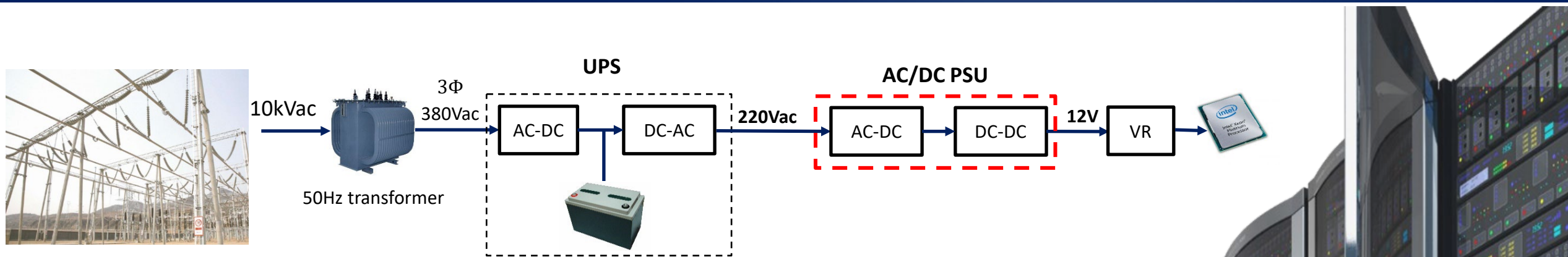
广州, 2023.11

[ir@navitassemi.com](mailto:ir@navitassemi.com)



- **高功率密度高效率服务器电源是当前数据中心的发展要求**
  - 数据中心服务器电源的钛金效率要求
  - 数据中心服务器电源的超高功率密度要求
- **CRPS185 3200W钛金服务器电源技术方案讨论**
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  - 基于第三代半导体(SiC/GaN)方案的可行性分析
- **纳微第三代半导体SiC/GaN助力实现CRPS185 3200W钛金Plus服务器电源**
  - 纳微650V集成驱动Toll封装GaN产品
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- **纳微CRPS185 3200W 钛金Plus服务器电源方案**
  - 规格介绍
  - 电路拓扑架构方案
  - 结构设计及thermal 仿真设计
  - 纳微CRPS185 3200W 钛金Plus服务器电源测试结果
  - 300kHz GaN based 3200W LLC Vs 150kHz Si based 3200W LLC

# 传统数据中心供电架构及其耗电量



数据中心每年耗电量占全年总社会用电量**3%**以上，相当于1.5个**三峡**年发电量

**1%**的效率提升，每年可节省约1个**新安江水电站**发电量



# 高效率服务器电源是当前数据中心的发展要求



80 PLUS 计划是由美国能源署出台，Ecos Consulting 负责执行的一项自愿认证计划，旨在促进计算机和服务器电源的能源高效利用。

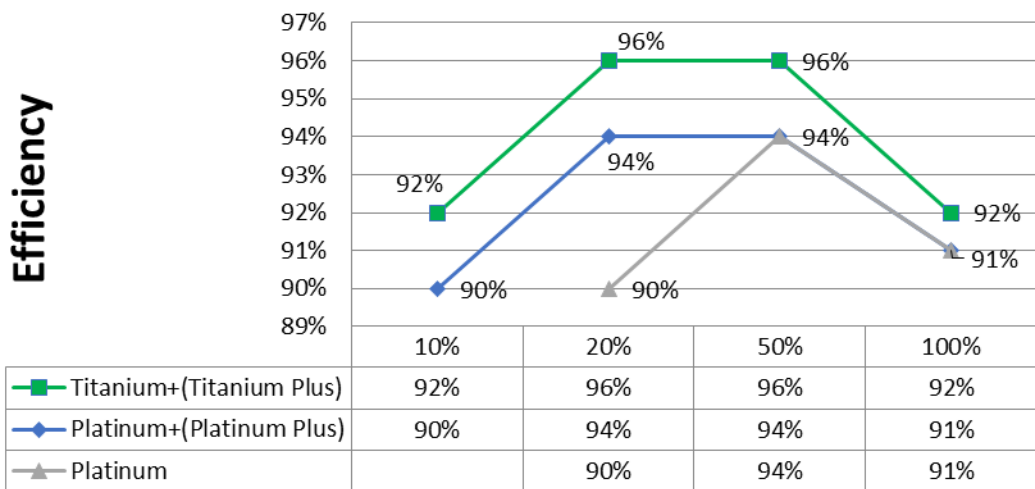
80PLUS 认证	负载	白牌	铜牌	银牌	金牌	铂金	钛金
		80 PLUS	80 PLUS Bronze	80 PLUS Silver	80 PLUS Gold	80 PLUS Platinum	80 PLUS Titanium
230V Internal Redundant	10%	N/A	--	--	--	---	90%
	20%		81%	85%	88%	90%	94%
	50%		85%	89%	92%	94%	96%
	100%		81%	85%	88%	91%	91%

Requirement	Output/Load	Efficiency				Power Factor				80 Plus	
		10%	20%	50%	100%	10%	20%	50%	100%	230 V non-redundant	230 V redundant
Lot 9 (March 2020)	Multi	--	88%	92%	88%	--	--	0.90	--	Gold	Gold
	Single	--	90%	94%	91%	--	--	0.95	--	Platinum*	Platinum
Lot 9 (Jan. 2023)	Multi	--	90%	94%	91%	--	--	0.95	--	Platinum*	Platinum
	Single	90%	94%	96%	91%	--	--	0.95	--	Titanium	Titanium



欧盟对高效数据中心电源提出了明确的计划 ErP-lot9 2023→单路输出电源2023年需要满足钛金效率要求

Vin=230VAC@25C exclude fan



3200W 服务器电源常规负载	3年可省电/每台 (Titanium+ Vs Platinum+)	3年可减排/每台 (Titanium+ Vs Platinum+)
30% load (960W)	-757kWh ( ¥ -454)	755千克 二氧化碳 303千克标准煤

\*注：节省一度电，相当于减少0.997千克二氧化碳排放，相当于减少0.4千克的标准煤使用

- 相比于铂金/铂金+ 效率，每台3200W钛金+效率电源3年可节省757度电，每台电源大约可**节省454元**成本，**减少755 kg二氧化碳**排放和**303Kg标准煤**使用
- 采用钛金/钛金+ 效率，还可以提高满载效率，这有利于thermal，寿命

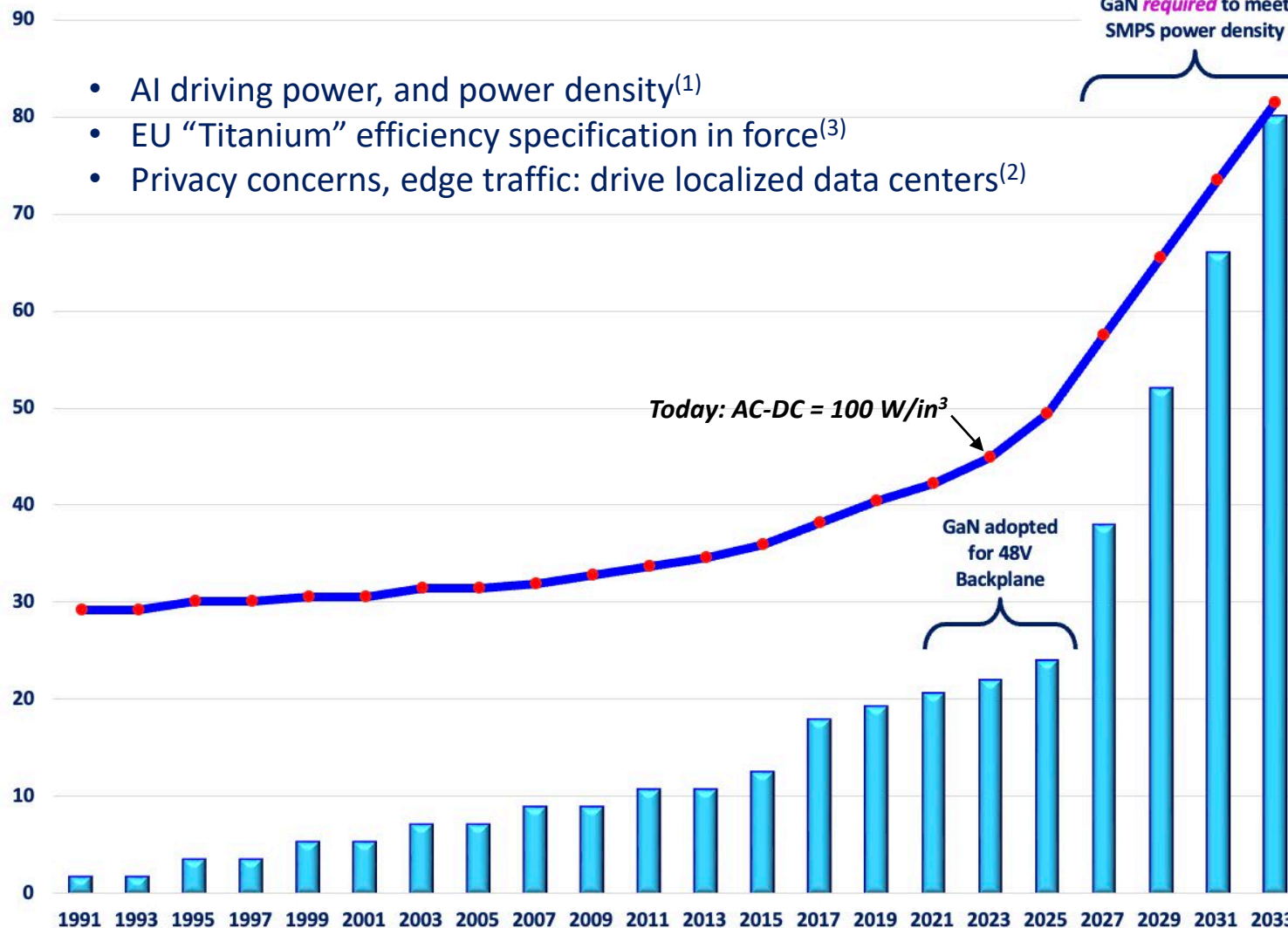
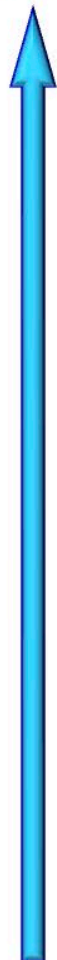
# 高功率密度服务器电源是当前数据中心的发展要求



AUTONOMOUS VEHICLES  
4000GB

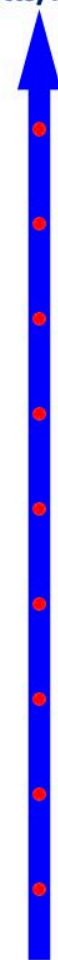


Rack Power  
(kWatts)



- AI driving power, and power density<sup>(1)</sup>
- EU “Titanium” efficiency specification in force<sup>(3)</sup>
- Privacy concerns, edge traffic: drive localized data centers<sup>(2)</sup>

AC-DC Power  
Density  
(Watts/Inch<sup>3</sup>)



1. Cerebras white paper / website  
 2. TD Cowen, per “AI to drive data center investments”, LightReading.com, 4-26-23  
 3. European Union ‘Directive 2009/125/EC, 2019 Annex’, power supplies must be >96% efficiency peak, as of 1-1-23

# 高功率密度服务器电源是当前数据中心的发展要求

英伟达 GPU



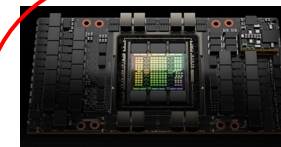
NVIDIA P100



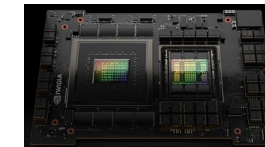
NVIDIA V100



NVIDIA A100



NVIDIA H100



NVIDIA GH200

GPU功耗

300W

350W

400W

700W

1000W

AI服务器电源



CRPS185 2000W~2400W  
PD: 61~74W/inch<sup>3</sup>



CRPS185 2.6kW/2.7kW  
PD: 83W/inch<sup>3</sup>



CRPS185 3.2kW  
PD: 98W/inch<sup>3</sup>



CRPS185 4.5kW ?  
PD: >138W/inch<sup>3</sup>



➤ 越来越强大的GPU在AI服务器的应用，加速了AI服务器电源的功率和功率密度演进和发展

LLC 方案 PFC 方案	<150kHz Si based LLC	<150kHz GaN based LLC	300kHz GaN based LLC	300kHz Si based LLC
<b>Bridge Boost PFC</b> 	<ul style="list-style-type: none"> <li>效率 <math>98.2\% \times 97.6\% = 95.8\%</math></li> <li>效率不满足</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.2\% \times 97.7\% = 95.9\%</math></li> <li>效率不满足</li> </ul>	效率 $98.2\% \times 97.4\% = 95.6\%$ <ul style="list-style-type: none"> <li>效率不满足</li> </ul>	效率 $98.2\% \times 97\% = 95.2\%$ <ul style="list-style-type: none"> <li>效率不满足</li> </ul>
<b>Active Bridge Boost PFC</b> 	<ul style="list-style-type: none"> <li>效率 <math>98.6\% \times 97.6\% = 96.2\%</math></li> <li>占用空间大, 成本高</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.6\% \times 97.7\% = 96.3\%</math></li> <li>占用空间大, 成本高</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.6\% \times 97.4\% = 96.0\%</math></li> <li>占用空间大, 成本高</li> </ul>	效率 $98.6\% \times 97\% = 95.6\%$ <ul style="list-style-type: none"> <li>占用空间大, 成本高</li> </ul>
<b>Bridgeless H-PFC</b> 	<ul style="list-style-type: none"> <li>效率 <math>98.4\% \times 97.6\% = 96.0\%</math></li> <li>MOS数量多, 成本高</li> <li>驱动复杂</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.4\% \times 97.7\% = 96.1\%</math></li> <li>MOS数量多, 成本高</li> <li>驱动复杂</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.4\% \times 97.4\% = 95.8\%</math></li> <li>MOS数量多, 成本高</li> <li>驱动复杂</li> </ul>	效率 $98.4\% \times 97\% = 95.4\%$ <ul style="list-style-type: none"> <li>MOS数量多, 成本高</li> <li>驱动复杂</li> </ul>
<b>Bridgeless Totem PFC with SiC/GaN</b> 	<ul style="list-style-type: none"> <li>效率 <math>98.8\% \times 97.6\% = 96.4\%</math></li> <li>管子数量少, 成本合理</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.8\% \times 97.7\% = 96.5\%</math></li> <li>效率裕量高, 钛金Plus</li> </ul>	<ul style="list-style-type: none"> <li>效率 <math>98.8\% \times 97.4\% = 96.2\%</math></li> <li>管子数量少, 成本合理</li> <li>空间小, 成本低</li> </ul>	效率 $98.8\% \times 97\% = 95.8\%$ <ul style="list-style-type: none"> <li>效率不满足</li> </ul>

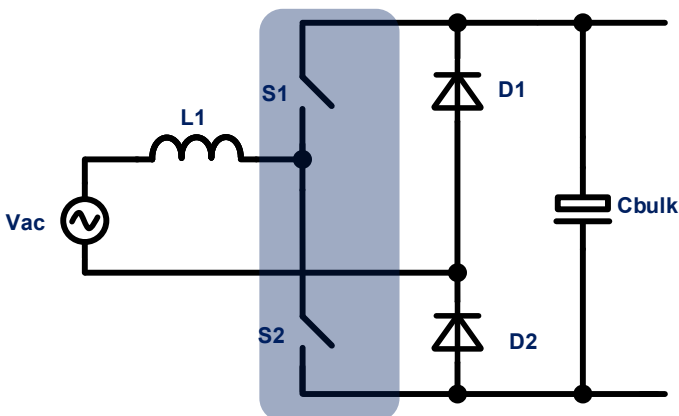
➤ 基于SiC/GaN的无桥图腾柱PFC是实现3200W高功率密度的同时，保持钛金效率的必选方案



Parameter	Si(IPT60R055CFD7)	SiC(G3F45MT06L)	GaN(NV6512C)	Remark
$R_{DS(ON)}$ vs Temp (@100°C)	1.65x	<b>1.15x</b>	1.75x	Lower is better, lower conduction loss
Temp rating( $T_{jmax}$ )	150°C	<b>175°C</b>	150°C	Higher is better
$Q_g$	67nC	47nC	<b>10.5nC</b>	Lower is better, Lower driver loss
$Q_{co(tr)}$	987pF	158pF	<b>139pF</b>	Lower is better, Lower switching loss
$Q_{rr}$	<b>1220nC</b>	102nC	<b>0</b>	Lower is better, Lower reverse recovery loss
$V_{GS(TH)_{min}}$	<b>3.5V</b>	2.1V	Integrated driver	Higher is better, Easier to drive

- SiC 更适合用于大电流，对热要求较高的场合
- GaN 更适合用于高频，效率要求更高的场合

## CCM TTP PFC



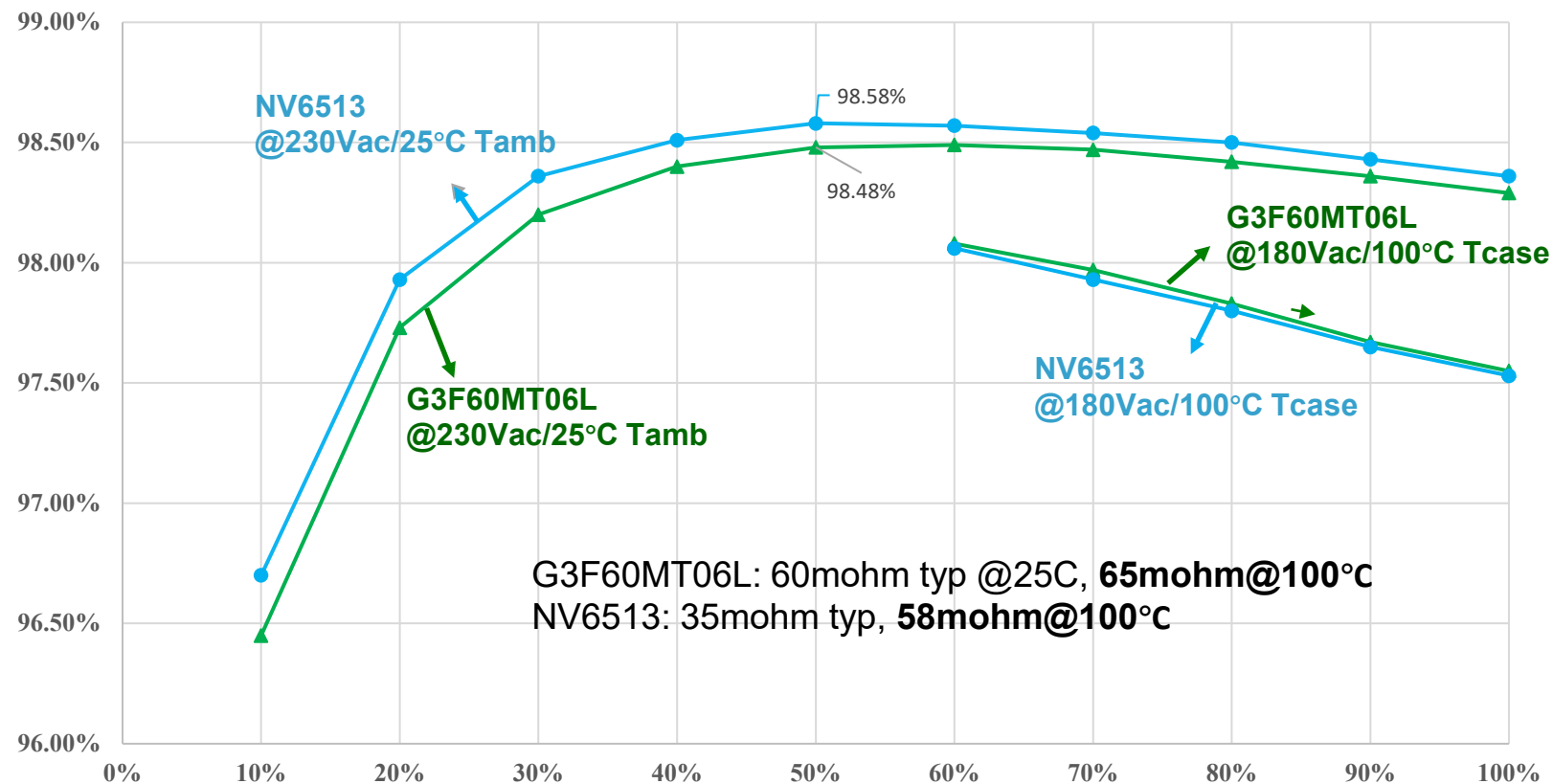
### SiC (Navitas:G3F60MT06L)

- $R_{dson}=60\text{mohm typ}$
- $R_{dson @100C}=65\text{mohm}$
- $Q_{rr}=102\text{nC}$
- $Co(tr)=158\text{pF}$
- $Q_g=47\text{nC}$

### GaN (Navitas:NV6513)

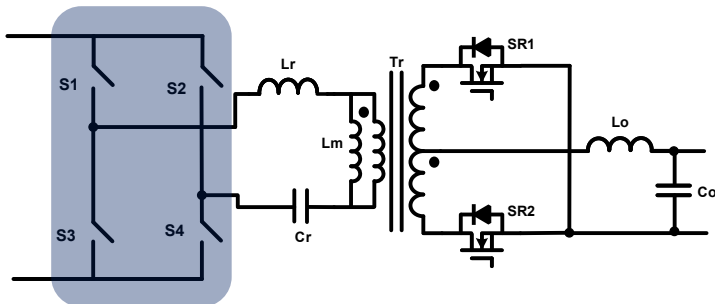
- $R_{dson}=32\text{mohm typ}$
- $R_{dson@100C}=58\text{mohm}$
- $Q_{rr}=0$
- $Co(tr)=139\text{pF}$
- $Q_g=10.5\text{nC}$

## 2kW CCM Totem PFC efficiency (including EMI loss and Aux power loss)



	PSU ambient temp	PFC fast switch temp	Temp rise
<b>NV6513(63mohm@100C)</b>	41.24°C	86.99°C	<b>45.75°C</b>
<b>G3F60MT06L(66mohm@100C)</b>	41.5°C	84.5°C	<b>43.0°C</b>

## Full bridge LLC



### Si (IFX:IPT60R055CFD7)

- $R_{dson}=45\text{mohm typ, } 55\text{mohm max}$
- $C_{o(tr)}=987\text{pF}$
- $Q_g=67\text{nC}$

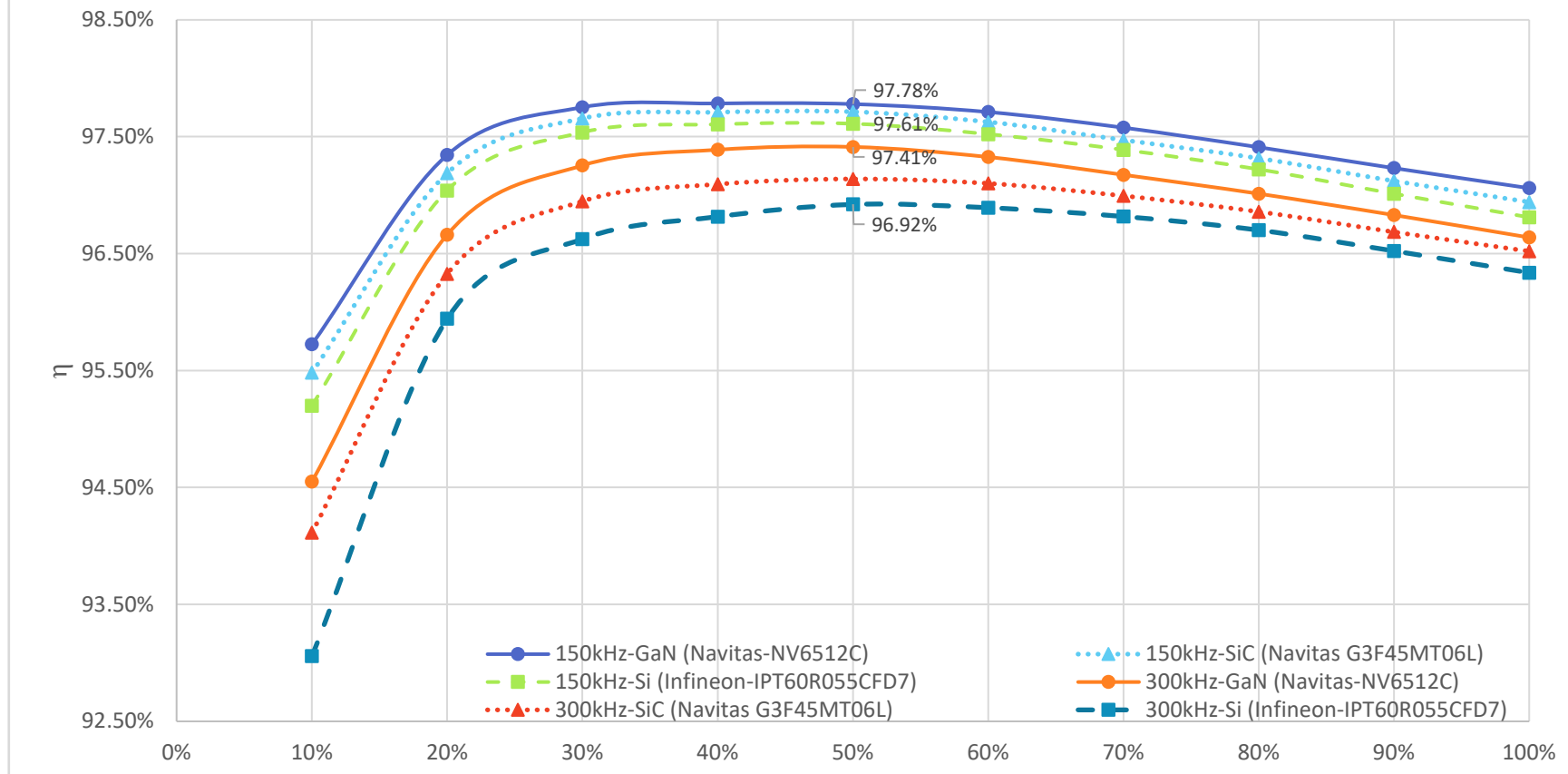
### SiC (Navitas:G3F45MT06L)

- $R_{dson}=45\text{mohm typ, } 60\text{mohm max}$
- $C_{o(tr)}=158\text{pF}$
- $Q_g=47\text{nC}$

### GaN (Navitas:NV6512C)

- $R_{dson}=45\text{mohm typ, } 55\text{mohm max}$
- $C_{o(tr)}=139\text{pF}$
- $Q_g=10.5\text{nC}$

Efficiency Curves of LLC with GaN/SiC/Si Device, including Oring, connector loss, driver loss



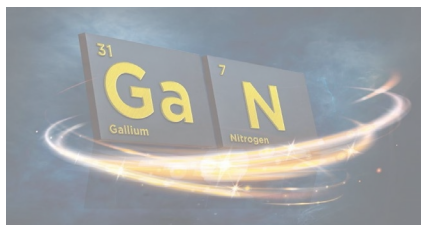
- When freq increased from 100kHz to 300kHz,
  - 1) Si MOS eff will drop a lot → Si MOS can NOT be used in high frequency application
  - 2) GaN can keep higher eff, especially at light load → GaN is preferred in high frequency



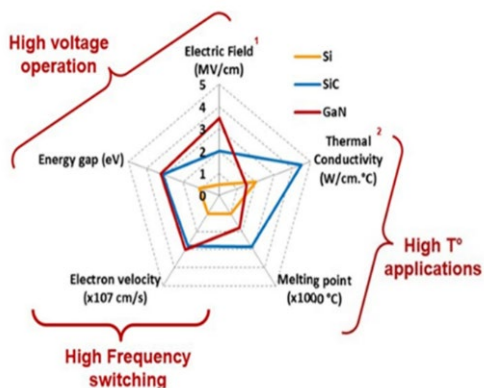
## *Pure-Play Next-Gen Power Semiconductors*

August 15th, 2022: Navitas Semiconductor, industry-leader in gallium nitride power ICs, acquired GeneSiC Semiconductor, silicon carbide pioneer and industry leader

# 纳微 SiC/GaN助力实现CRPS185 3200W钛金Plus电源



## GaN Physical Performance



材料特性	器件优势	系统优势
禁带宽度 (3.4倍)	耐高温	易散热
饱和电子漂移速度(2.4倍)	开关快	体积小
电子迁移率 (1.5倍)	电阻低	损耗小
击穿场强 (1.1倍)	耐高压	功率大

eMode FET (normally off)

dMode FET (normally on)

- 需要特殊的6V专有控制器
- 驱动和GaN是分立的，对Layout要求比较高并且容易受干扰
- 驱动的可靠性和一致性目前还没有确认

Integration

GaN Discrete  
*Complex gate drive*

Extra Si FET in 'cascode' configuration

- 两颗chip (一颗Si mos, 一颗GaN die)
- 没有驱动控制dv/dt
- 没有任何保护
- Si Mos, 易驱动

Co-pack

Navitas

Power IC

GaN Power (FET), GaN Drive, Control, Protection

120+ Patents

兼容所有的现有PWM控制器

0寄生参数消除开关尖峰噪声, 保证Gate可靠性及高频下工作 Dv/dt和EMI控制

TEXAS INSTRUMENTS

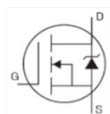
Si controller/driver + Si FET cascode + GaN dMode FET

- 驱动和GaN集成
- dv/dt和EMI控制
- OCP/OTP/UVLO

GaNFast™ with GaNSense™

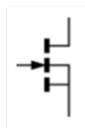
- 兼容所有的现有PWM控制器
- 0寄生参数消除开关尖峰噪声, 保证Gate可靠性及高频下工作
- Dv/dt和EMI控制
- OTP/OCP/UVLO保护
- 集成Rcs, 减小BOM, 提升效率

## Si MOSFET



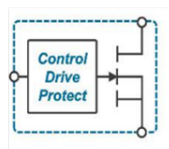
- Old, slow
- High  $Q_g$
- High  $C_{OSS}$
- $F_{sw} < 100$  kHz

## Discrete GaN



- External gate drive
- $dV/dt$  sensitivity
- Layout sensitivity
- ESD sensitivity
- Unknown reliability
- Unknown robustness

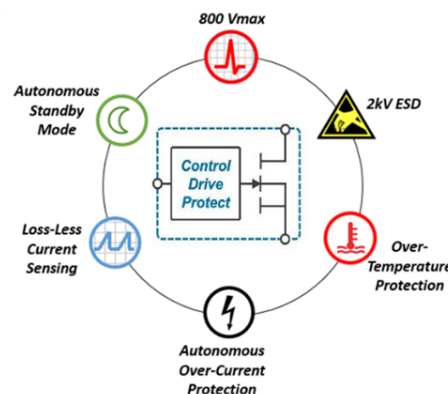
## GaNFast™ 200-300 kHz



### GaNFast:

- ✓ Internal Gate
- ✓ Integrated Gate Drive
- ✓  $dV/dt$  Immunity
- ✓ Layout Insensitive
- ✓ 2 kV ESD rating
- ✓ Proven Reliability
- ✓ Proven Robustness

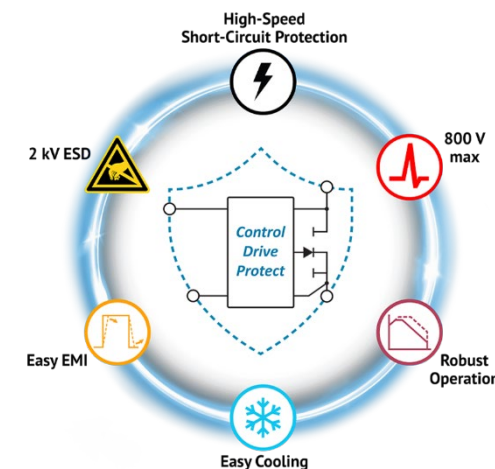
## GaNSense™ 500 kHz



### GaNFast plus:

- ✓ Autonomous Standby
- ✓ Autonomous Protection
- ✓ Loss-less Current Sensing
- ✓ High Precision
- ✓ High Efficiency

## GaNSafe™



### GaNSense plus:

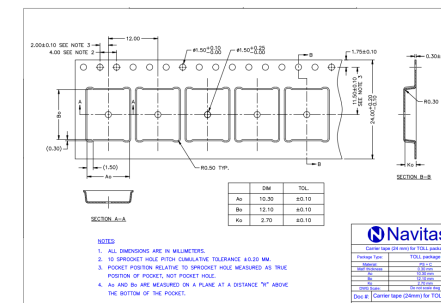
- ✓ Desat detect Short Circuit Protection with ultra-fast 300ns latency
- ✓ Robust, thermally enhanced packaging: ultra-low  $R_{\theta JUNC-AMB}$  and BLTC Reliability
- ✓ 4<sup>th</sup> Gen integrated GaN gate drive with positive TempCo  $V_{GS}$  regulation
- ✓ Integrated Miller Clamp (no negative gate bias, higher 3<sup>rd</sup> quadrant efficiency)
- ✓ Programmable  $dV/dt$  Turn-ON/OFF slew rate control for ease of design



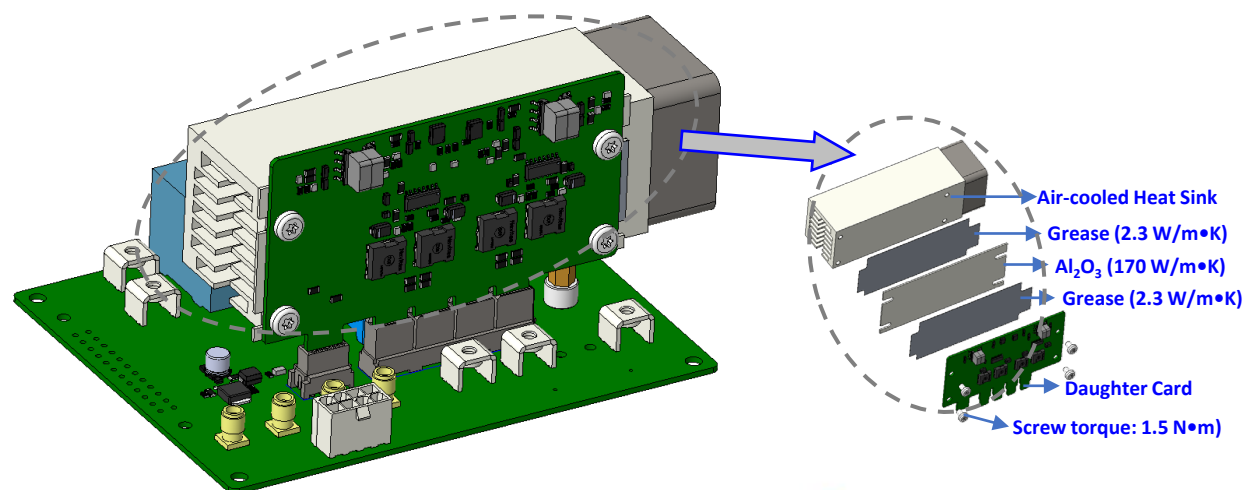
**Proved GaN Reliability in high volume segments, accelerated GaN adoption, ramped to #1 GaN Supplier**

# 纳微 SiC/GaN助力实现CRPS185 3200W钛金Plus电源

Part#	V <sub>DS</sub> (Cont, Max) (V)	V <sub>DS</sub> (Dyn, Max) (V)	R <sub>DS(ON)</sub> (Max 25°C) (mΩ)	I <sub>D</sub> (Max) (A)	Package	Evaluation Kit
NV6515	650	800	35	57	TOLL 10x10 Bottom-cool	Power Board, Full Bridge Daughter Card, and FanSink/TIM ~ configurable for DPT or Half-Bridge testing
NV6513			45	48		
NV6512			55	34		
NV6511			98	22		



TnR Ordering	
Mini-Reel (7" dia)	Qty500 Pcs "-MR" suffix
Standard (13" dia)	Qty2,000 Pcs



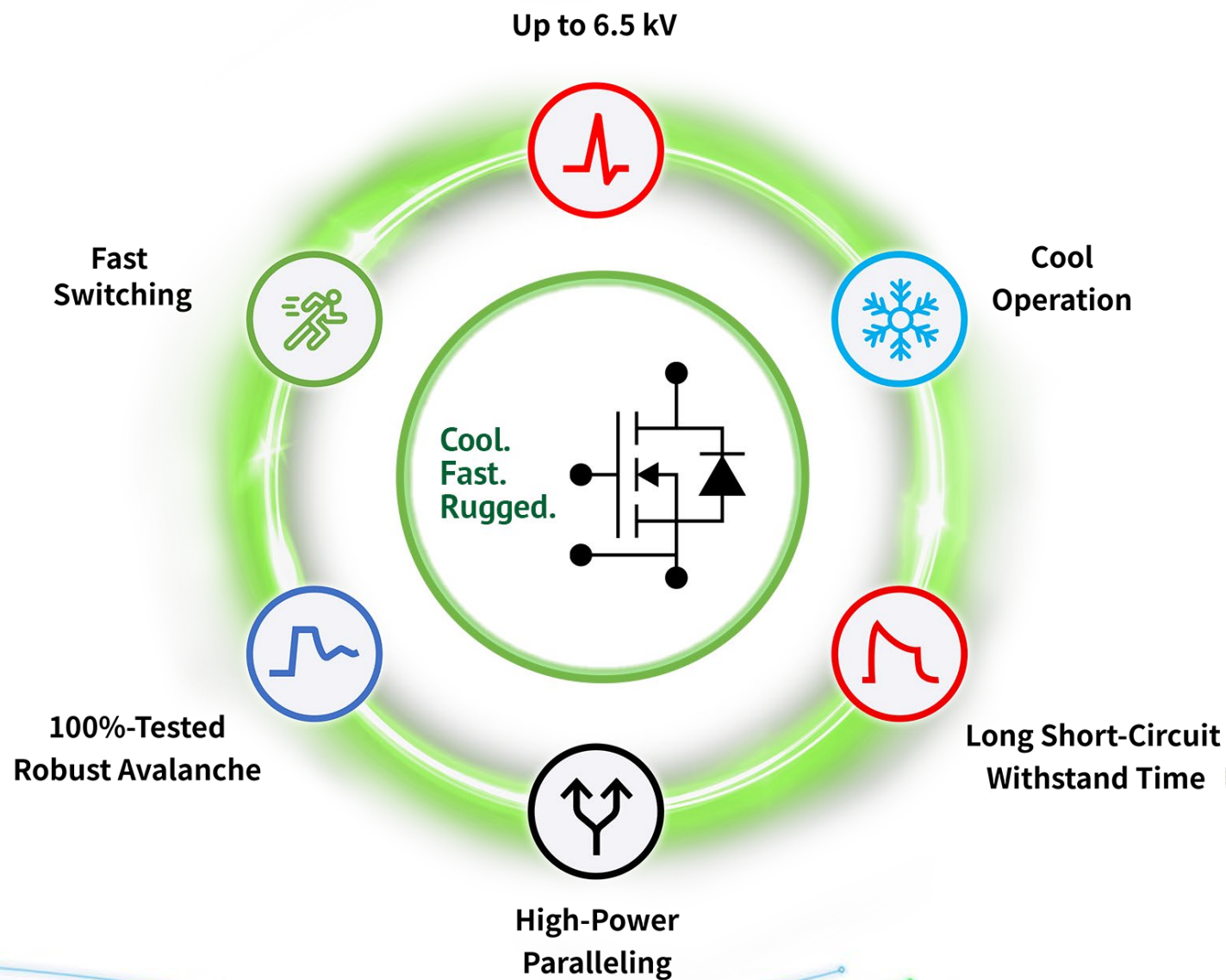
1. Samples and collateral available immediately to qualified customers

	<p><b>SiC Planar</b></p>	<p><b>SiC Trench</b></p>	<p><b>GeneSiC SiC MOSFET</b></p>
<b>Manufacturability</b>	<ul style="list-style-type: none"> <li>➤ Repeatable</li> <li>➤ High yield</li> <li>➤ Low cost</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Inconsistent trench-etch profile</b></li> <li>➤ <b>Lower yields</b></li> <li>➤ <b>High cost</b></li> </ul>	<ul style="list-style-type: none"> <li>✓ Repeatable</li> <li>✓ High yield</li> <li>✓ Low cost</li> </ul>
<b>Performance</b>	<ul style="list-style-type: none"> <li>➤ <b>High <math>R_{DS(ON)}</math> / area</b></li> <li>➤ <b>Slower switching FoM</b></li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Lower <math>R_{DS(ON)}</math> / area</b></li> <li>➤ <b>Faster switching FoM</b></li> <li>➤ <b>High <math>R_{DS(ON)}</math> / <math>\Delta</math> temp</b></li> </ul>	<ul style="list-style-type: none"> <li>✓ Lower <math>R_{DS(ON)}</math> / area</li> <li>✓ Fastest switching FoM</li> <li>✓ Lowest <math>R_{DS(ON)}</math> / <math>\Delta</math> temp</li> </ul>
<b>Reliability</b>	<ul style="list-style-type: none"> <li>➤ Rugged gate oxide (stable <math>V_{TH}</math>)</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Non-uniform gate oxide</b></li> </ul>	<ul style="list-style-type: none"> <li>✓ Rugged Gate oxide (stable <math>V_{TH}</math>)</li> <li>✓ Highest 100% tested avalanche</li> <li>✓ Long short-circuit withstand time</li> </ul>

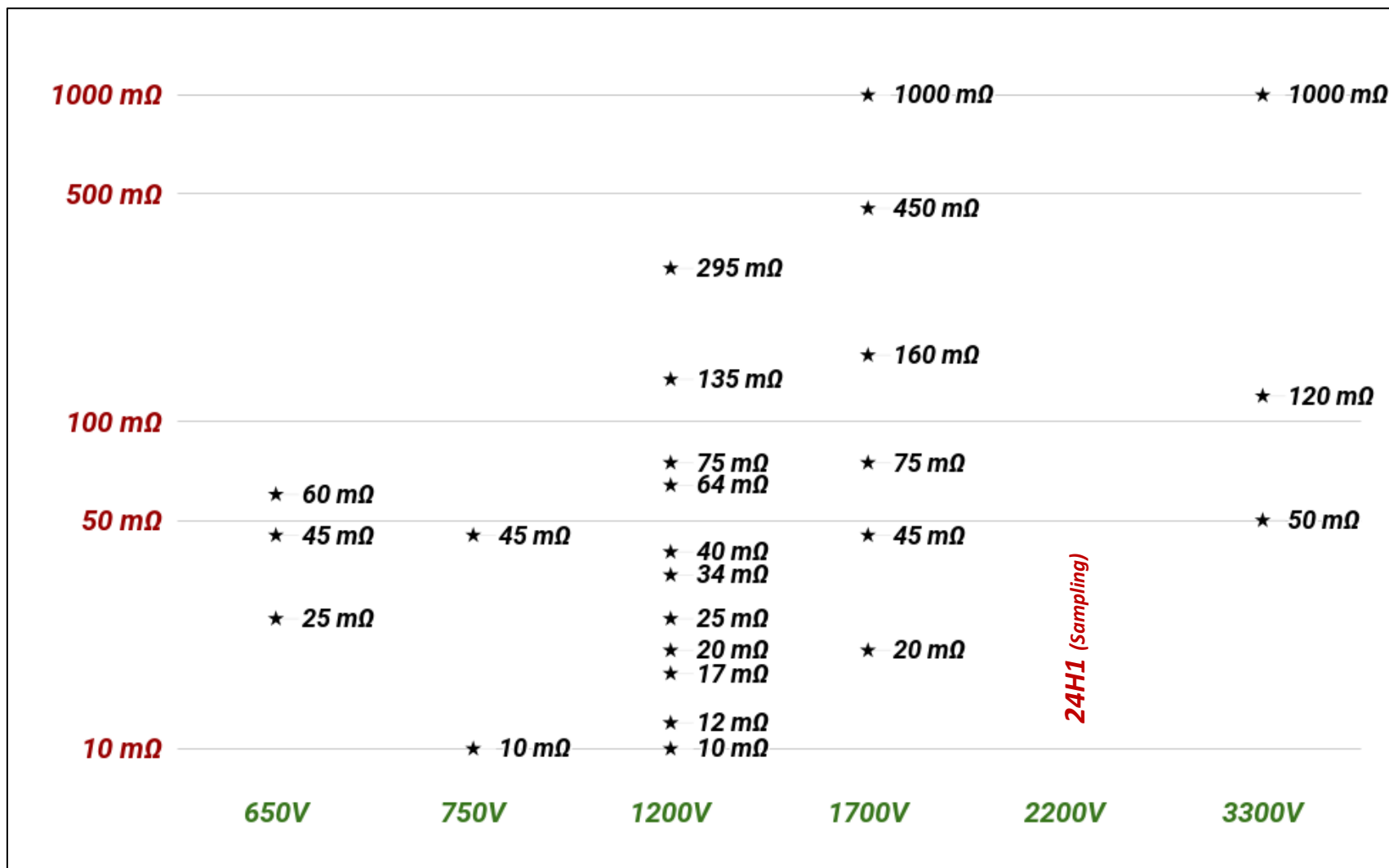
**Trench-Assist Planar Gate SiC MOSFET**



# 纳微 SiC/GaN助力实现CRPS185 3200W钛金Plus电源



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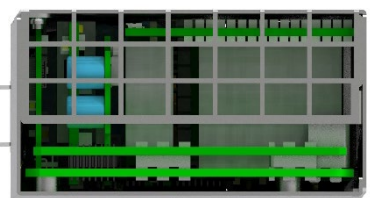
- ✓ 50+ SiC MOSFETs ratings
- ✓ Discrete
- ✓ Bare Die
- ✓ Power Modules



## 纳微 CRPS185 3200W



前视图



后视图

### BRIEF SPECIFICATION

Input voltage range	HL:220 ~ 264 Vac LL:90 ~ 140 Vac
Frequency	47~63Hz
Output power(Consider C20 safety)	<b>3200W@220Vac~240Vac, 3000W@200Vac~219Vac</b>
Output voltage & current	12.2V/262A
Standby output voltage & current	12V/2.5A
Efficiency	Titanium(>96%@50% load)
Operating temperature range	-5C~+55C
Hold up time	<b>14ms@2400W, 12ms@2700W, 10ms@3200W</b>
Power Density	98W/inch <sup>3</sup>
Oring	Yes
Special features	Active current sharing OC/OV/UV/OT I <sup>2</sup> C

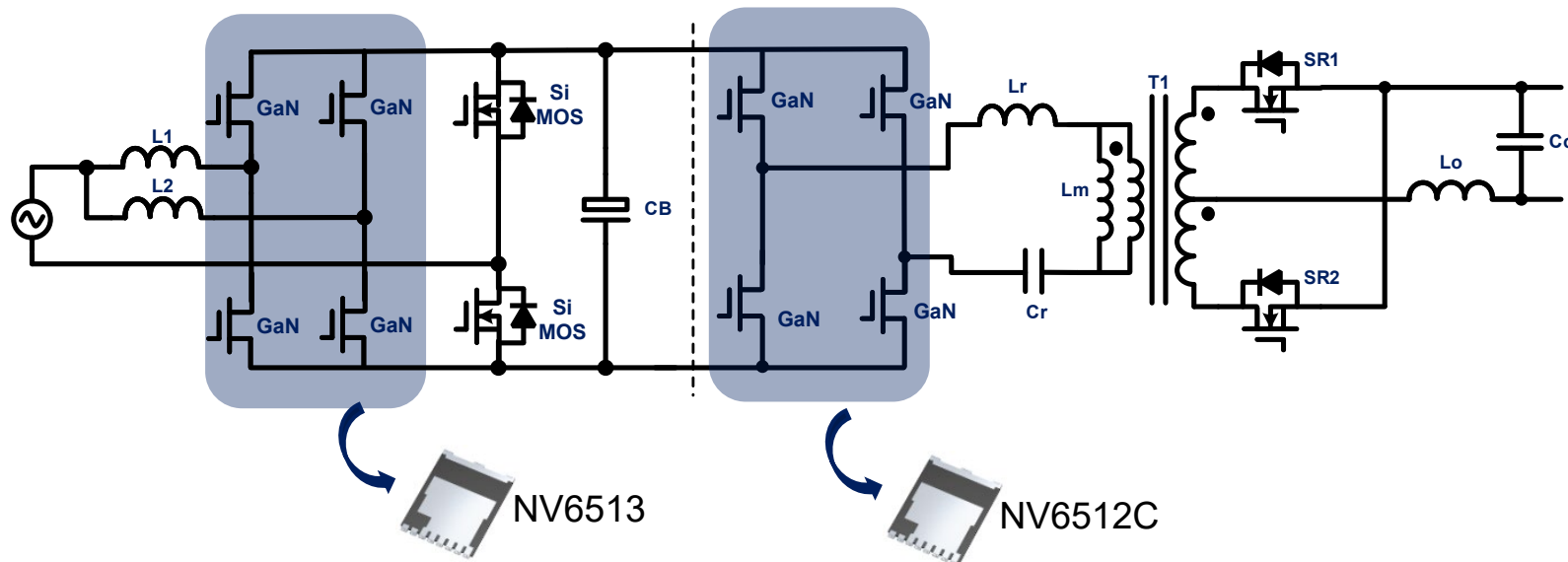
### MECHANICAL SPECIFICATION

Size L x W x H mm	185 (L)*73.5 (W)*39 (H)
Cooling	Internal fan



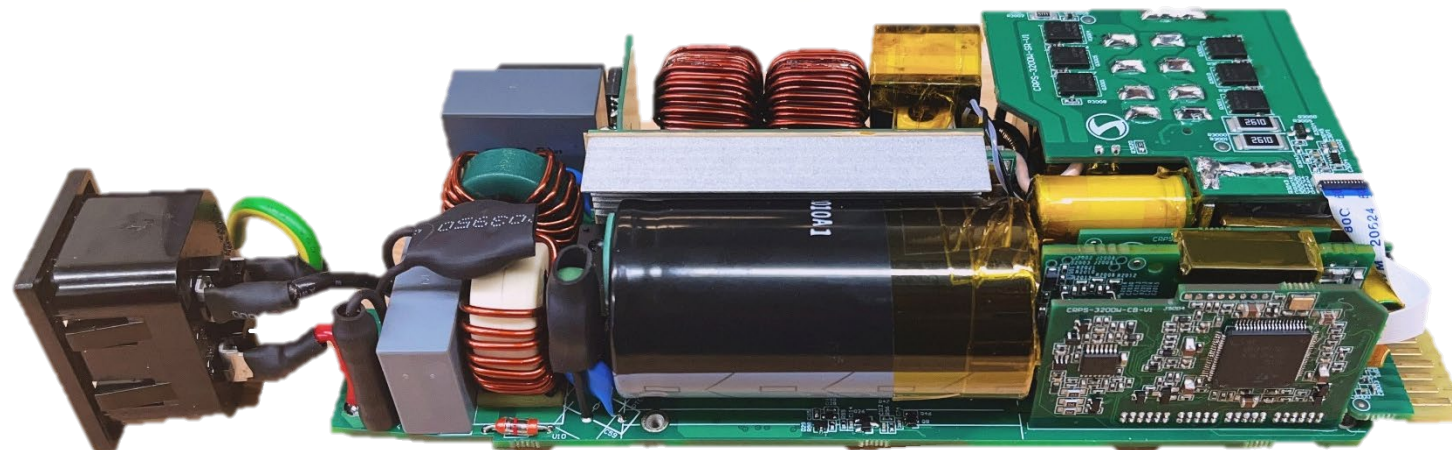
Interleaved CCM TP PFC(65kHz)

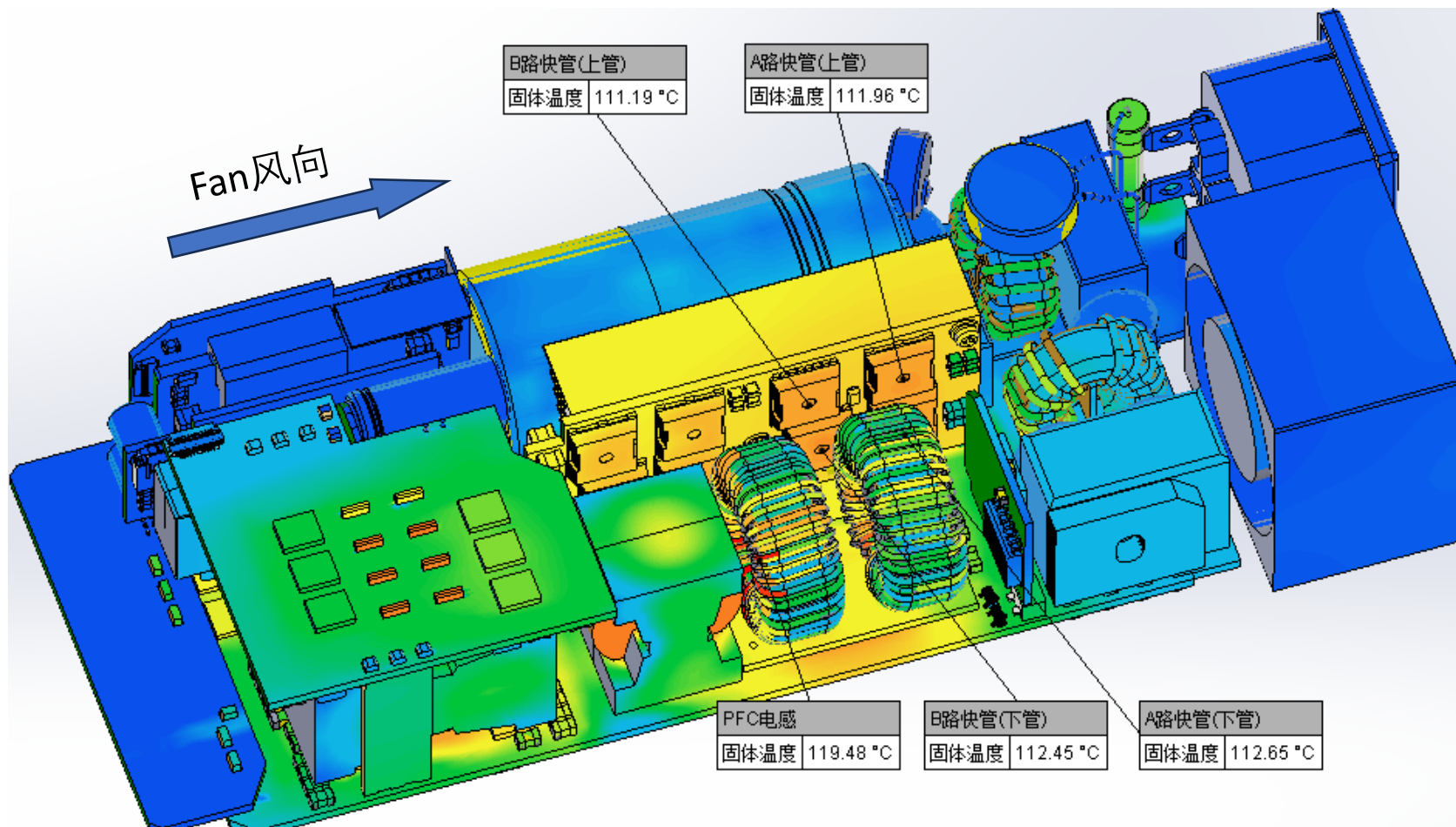
130kHz FB LLC+SR



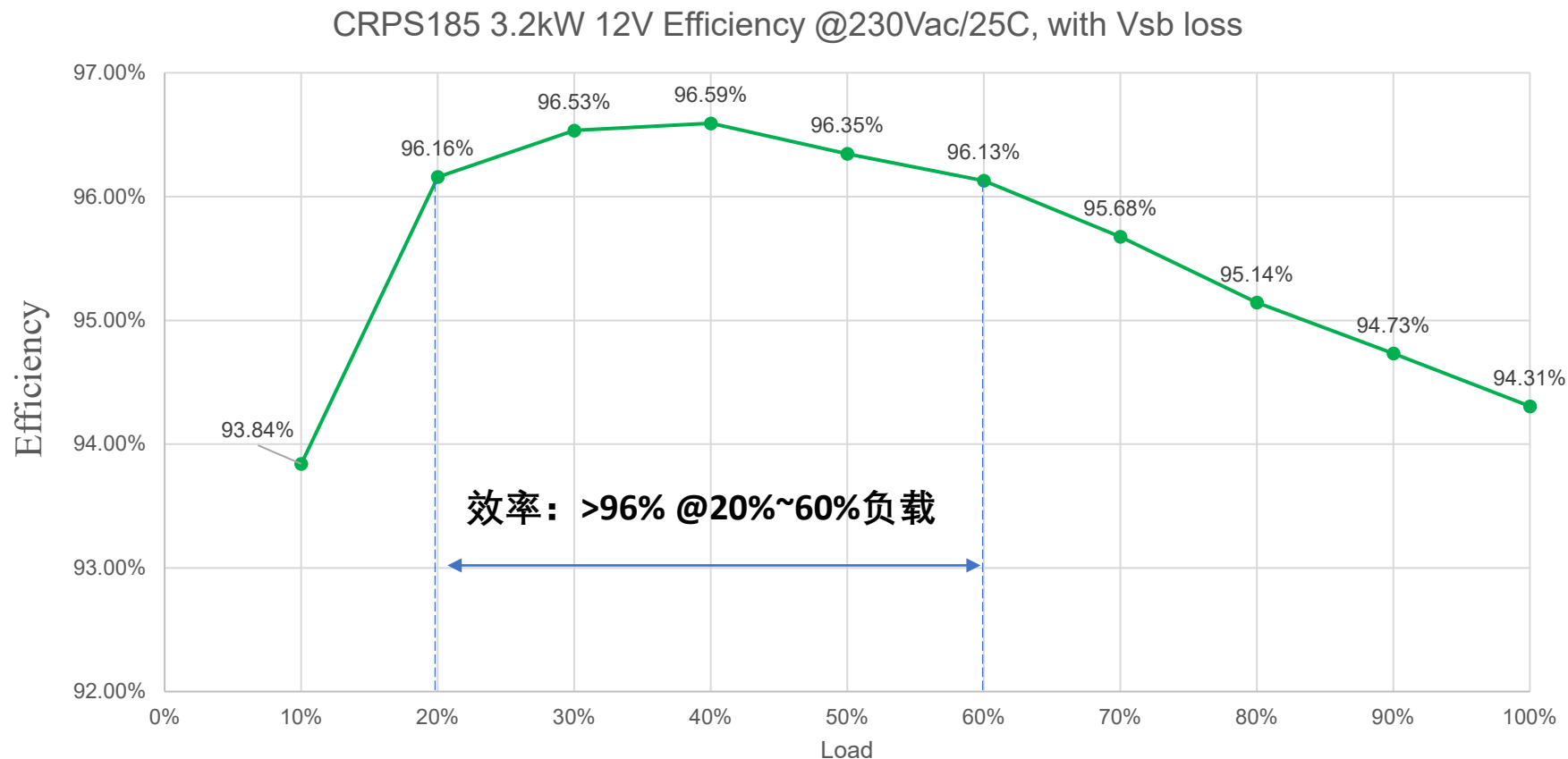
## 纳微 CRPS185 3200W 平台

- 兼容 2.7kW, 3kW, 3.2kW
- 功率密度高达98W/inch<sup>3</sup>
- Titanium+ Efficiency: 96.3% @ 50% load, >96% @ 20%~60% load
- Hold up time: 12ms @ 2700W, 10ms @ 3200W





- Thermal仿真结果显示，纳微CRPS185 3200W 电源方案可很好满足热要求 (GaN器件仿真温度低于113°C)



- 纳微CRPS 3200W 服务器电源方案效率可以很好满足80 Plus 钛金效率要求. 其中峰值效率为 **96.6% @ 40%** 负载, 半载下效率为 **96.35%**, 同时在 **@ 20%~60%** 负载范围内效率都 **大于96%**, **超钛金效率 (Titanium Plus)**

Key Component	Test point	1. 30C 2. 180Vac 2700W 3. Fan: PFB0412EN	1. 30C 2. 200Vac 3000W 3. Fan: PFB0412EN	1. 30C 2. 220Vac 3200W 3. Fan: PFB0412EN	1. 55C 2. 200Vac 3000W 3. Fan: PFB0412EN	1. 55C 2. 220Vac 3200W 3. Fan: PFB0412EN	IPC9592B- dreading	Result
Name	Test point	Temp/°C	Temp/°C	Temp/°C	Temp/°C	Temp/°C	Temp/°C	
Ambient		30.64	30.38	31.6	55.05	53.04	-	
PFC choke	1	67.01	72.53	74.07	115.89	114.77	130	PASS
Polarity MOS	2	65.77	71.3	72.72	105.74	106.22	125	PASS
<b>PFC GaN (high side)</b>	3	76.05	81.52	83.07	111.92	111.29	120	PASS
<b>PFC GaN (low side)</b>	4	75.63	81.56	83.36	114.14	113.33	120	PASS
<b>LLC Primary GaN</b>	5	63.33	69.8	73.86	106.61	109.19	120	PASS
LLC resonant choke	6	68.5	77.79	81.53	112.05	116.45	130	PASS
LLC SR MOS	8	72.11	82.43	88.73	110.95	115	125	PASS
ORING MOS	9	61.47	70.8	75.22	112.26	117.13	125	PASS

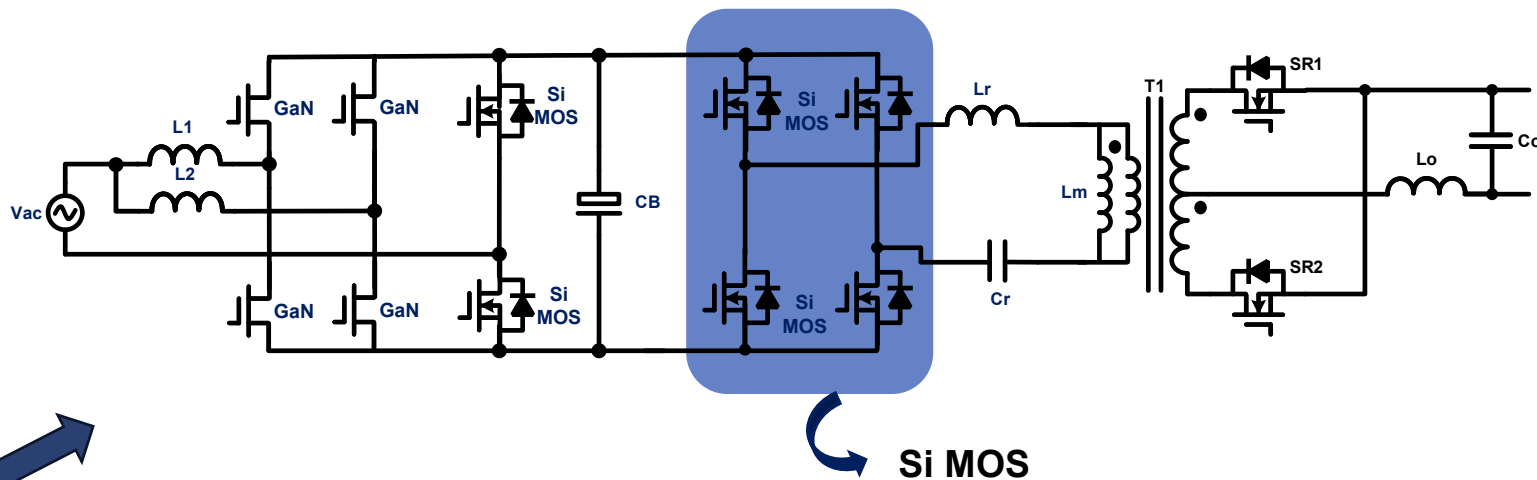
- PSU在环温55°C下，在最低输入电压180Vac下，内部GaN器件最高温度低于114.14°C，可以很好满足IPC9592B 的降额要求

## CRPS185 3200W Titanium PSU

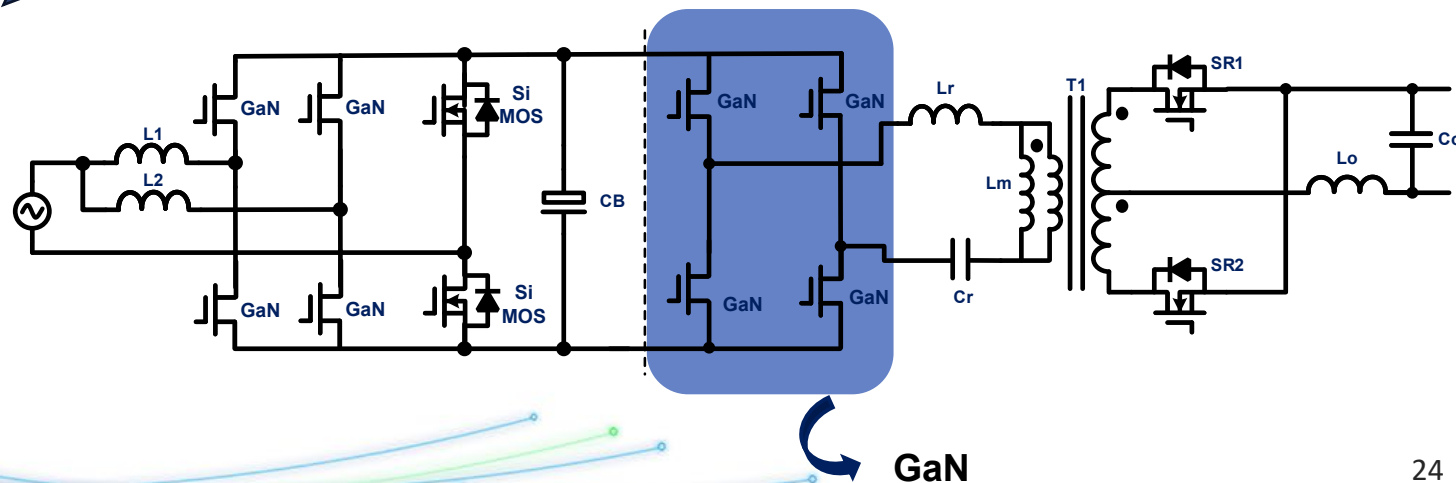


Interleaved CCM TP PFC

<150kHz **Si** based FB LLC

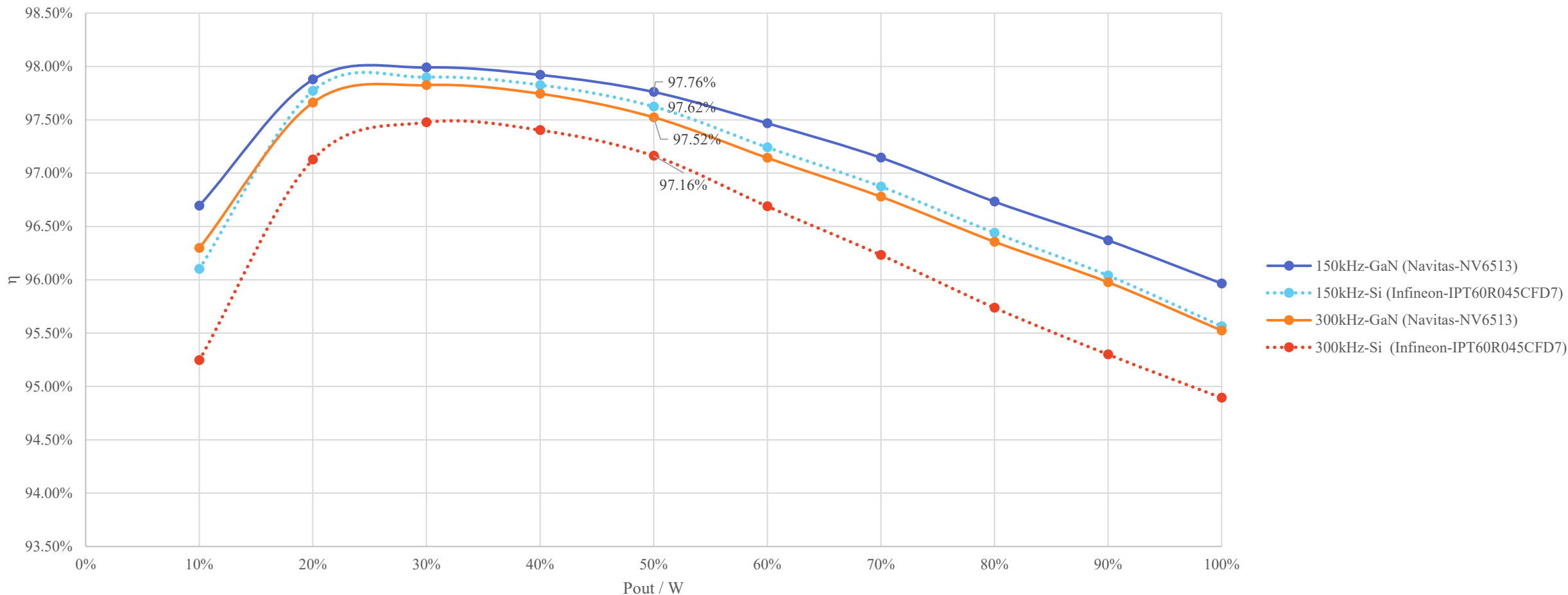


>300kHz **GaN** based FB LLC





Efficiency Curves of CRPS-3200W-LLC with GaN/Si Device

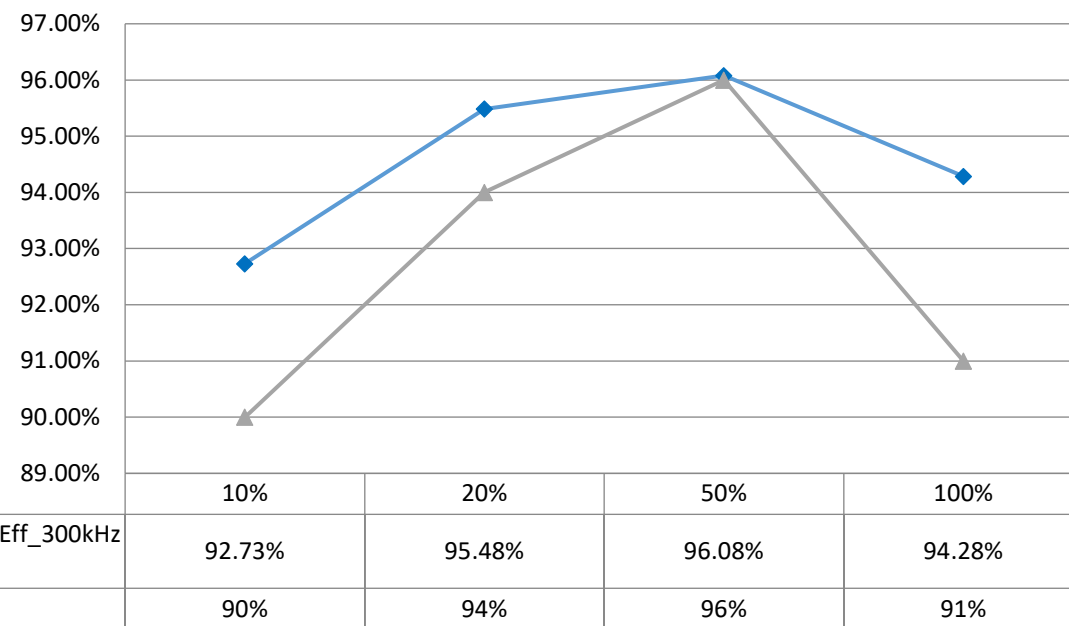


- LLC 效率: 150kHz GaN LLC > 150kHz Si ≈ 300kHz GaN >> 300kHz Si
- 300kHz GaN LLC 的效率略低于150kHz Si LLC的效率(0.1%左右), 依然可以实现整机的钛金效率要求

300kHz GaN based LLC CRPS185 3.2kW 12V Eff@230Vac, with Vsb loss						
Vin	Pin/W	Vout/V	Io/A	Pout/W	Eff	Load
230Vac	343.89	12.2651	26	318.8926	92.73%	10%
230Vac	667.1	12.2496	52	636.9792	95.48%	20%
230Vac	993.6	12.2374	78	954.5172	96.07%	30%
230Vac	1322.1	12.2288	104	1271.795	96.20%	40%
230Vac	1654	12.2241	130	1589.133	96.08%	50%
230Vac	1993.8	12.2389	156	1909.268	95.76%	60%
230Vac	2344.2	12.2831	182	2235.524	95.36%	70%
230Vac	2705.1	12.3367	208	2566.034	94.86%	80%
230Vac	3056.5	12.3506	234	2890.04	94.55%	90%
230Vac	3356.5	12.3619	256	3164.646	94.28%	100%

Efficiency

Vin=230VAC@25C , with Vsb loss



- 基于300kHz GaN LLC 的CRPS185 3200W PSU依然可以实现整机钛金效率的要求
- 副边SR依然是Si MOS, 可通过进一步降低驱动损耗提高效率

## Si基150kHz 3200W LLC

## GaN 基300kHz 3200W LLC

<p><b>Main Transformer</b></p>		<p><b>PQ3628</b> Size: 36mm*28mm*24mm</p>			<p><b>PQ3033</b> Size: 30mm*33mm*21mm</p>
<p><b>Resonant Choke</b></p>		<p><b>PQ2618:</b> Size: 26mm*18mm*19mm</p>			<p><b>PQ2018</b> Size: 20mm*18mm*14mm</p>
<p><b>Resonant Capacitor &amp; Output MLCC</b></p>		<p>630V 10nF 1206 *40pcs 16V 10uF 1206 *64pcs</p>			<p>630V 10nF 1206 *12pcs 16V 10uF 1206 *50pcs</p>
<p><b>Primary Switch</b></p>		<p><b>IPT60R055CFD7 *4pcs</b></p>			<p><b>NV6512C *4pcs</b></p>

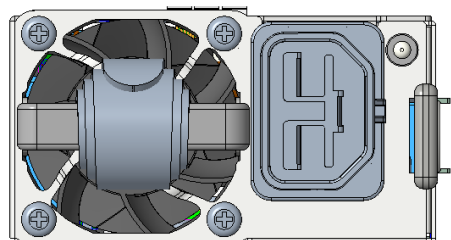
➤ LLC频率提高至300kHz后, LLC体积有近**15%~20%**的下降

## CRPS185 3200W 12V Titanium PSU LLC 方案对比

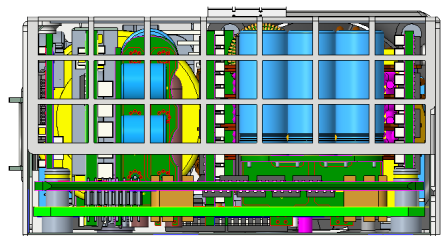
LLC方案	150kHz Full bridge LLC with Si (IPT60R055CFD7, 55mohm)	300kHz Full bridge LLC with GaN (NV6512C, 55mohm)	Remark/Cost Gap
LLC 效率	~97.6% @50% load	~97.5% @50% load	300kHz GaN LLC 依然可以实现整机钛金效率要求
LLC谐振电容	100nF, 1206 10nF *40pcs	30nF, 1206 10nF*12pcs	70% 成本降低 ↓
LLC谐振电感	PQ2718	PQ2018	15%成本降低 ↓
LLC主变压器	PQ3628	PQ3033	15%成本降低 ↓
LLC输出瓷片电容	1206 10uF*66pcs	1206 10uF*50pcs	25%成本降低 ↓
LLC总成本			>\$1.7成本降低 >5%LLC系统成本降低 ↓

- 300kHz GaN基3200W LLC 效率略低于150kHz Si 基 LLC(0.1%左右), 因此300kHz GaN 基 LLC 依然能很好满足钛金效率要求
- 采用300kHz LLC, 体积将降低**15%~20%**, 总成本可以降低 **\$1.7 ( >5% 系统成本的降低)**

## Navitas CRPS185 4500W 54V



Front Panel



Real Side

### BRIEF SPECIFICATION

Input voltage range	HL:180 ~ 264 Vac LL:90 ~ 132 Vac
Frequency	47~63Hz
Output power	<b>4500W</b> @220Vac~240Vac, <b>4200W</b> @200Vac~219Vac
Output voltage & current	54V/83.3A
Standby output voltage & current	12V/2.5A
Efficiency	> <b>97%</b> peak efficiency
Operating temperature range	-5C~+55C
Hold up time	<b>10ms</b> @4200W (Bus cap: 450V/1200uF(1500uF), 30mm*70mm)
Power Density	<b>138W/inch<sup>3</sup></b>
Oring	Yes
Special features	Active current sharing OC/OV/UV/OT I <sup>2</sup> C

### MECHANICAL SPECIFICATION

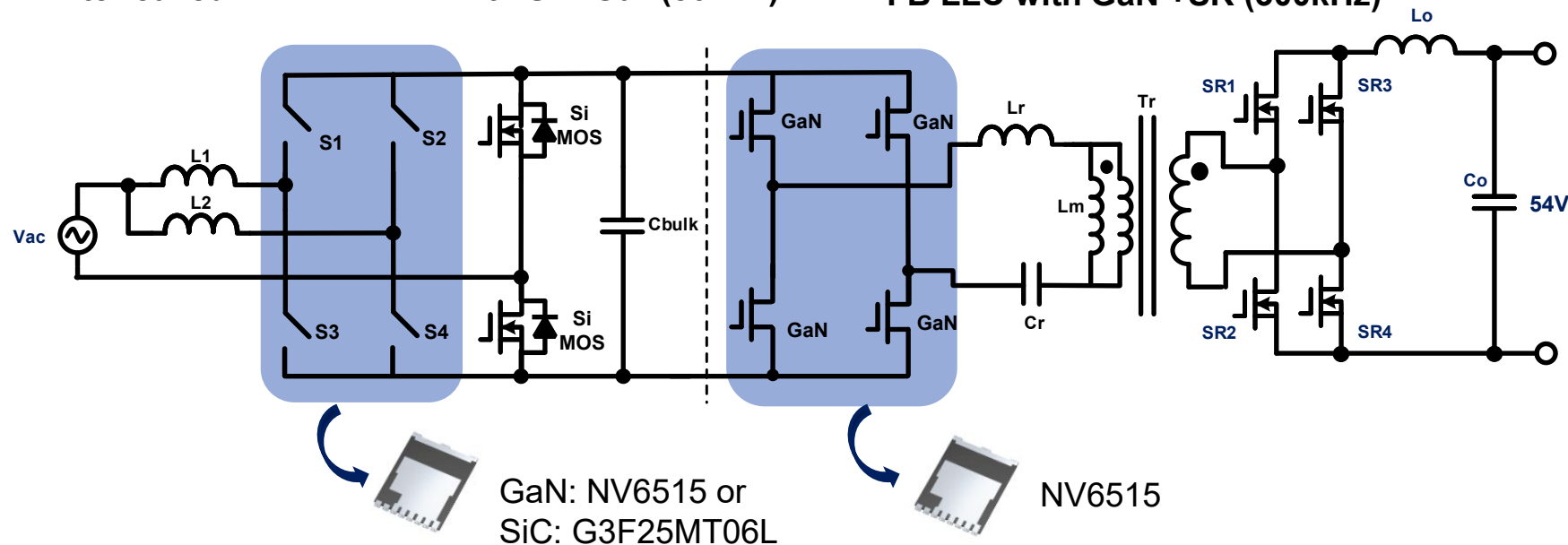
Size L x W x H mm	185 (L)*73.5 (W)*39 (H)
Cooling	Internal fan

## NVTS CRPS185 4500W 54V

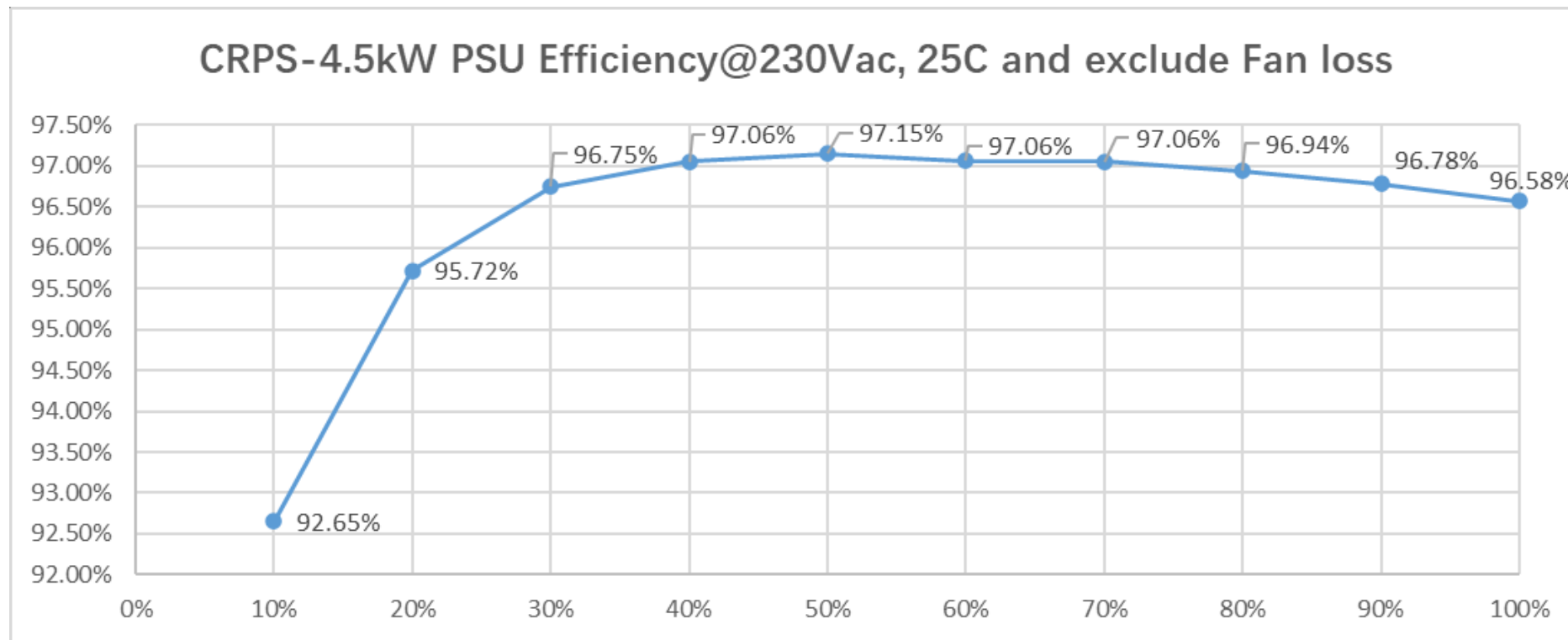


### Interleaved CCM TP PFC with SiC/GaN(80kHz)

### FB LLC with GaN +SR (300kHz)



- 功率密度高达 **138W/inch<sup>3</sup>**，得益于高频LLC设计(**300kHz**谐振频率)
- 在此功率密度(开关频率)下整机效率还能 **>97% @50% load**，得益于第三代半导体尤其是GaN的使用
- 如果LLC SR替换为GaN，驱动损耗大幅降低，整机效率将进一步提高



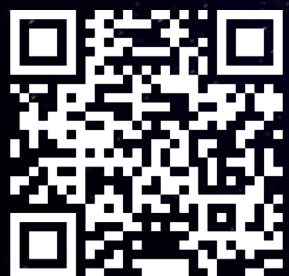
- Peak efficiency: **97.15%** @50% load
- Flat efficiency curve: >96.5% @30%~100% load, >97%@40%~70% load
- Much better than Titanium Efficiency(Titanium required 96%)

- AI服务器迫切需要CRPS185 3200W乃至更高的4200W电源，高功率密度高效率电源是AI服务器的基础保障
- 无桥图腾柱PFC + LLC 是实现CRPS185 3200W AI服务器电源的必然选择
- SiC更适合大电流，对热要求严格的场合； GaN更适合高频，效率要求更高的场合
- 纳微GaN具有集成驱动，短路电流保护等功能，有效解决了GaN驱动敏感等问题；纳微SiC具有内阻温漂小，超强的短路电流能力等突出优势
- 基于纳微SiC/GaN的CRPS185 3200W解决方案可以实现超钛金(钛金Plus)效率
- 300kHz GaN基 3200W LLC可以在满足整机钛金效率要求前提下，大幅缩小LLC体积，同时节省LLC系统成本
- 300kHz GaN基LLC不仅可以助力实现CRPS185 4500W 高达138W/inch<sup>3</sup>的功率密度，还可实现>97%的整机效率



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共同 Electrify Our World™”

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