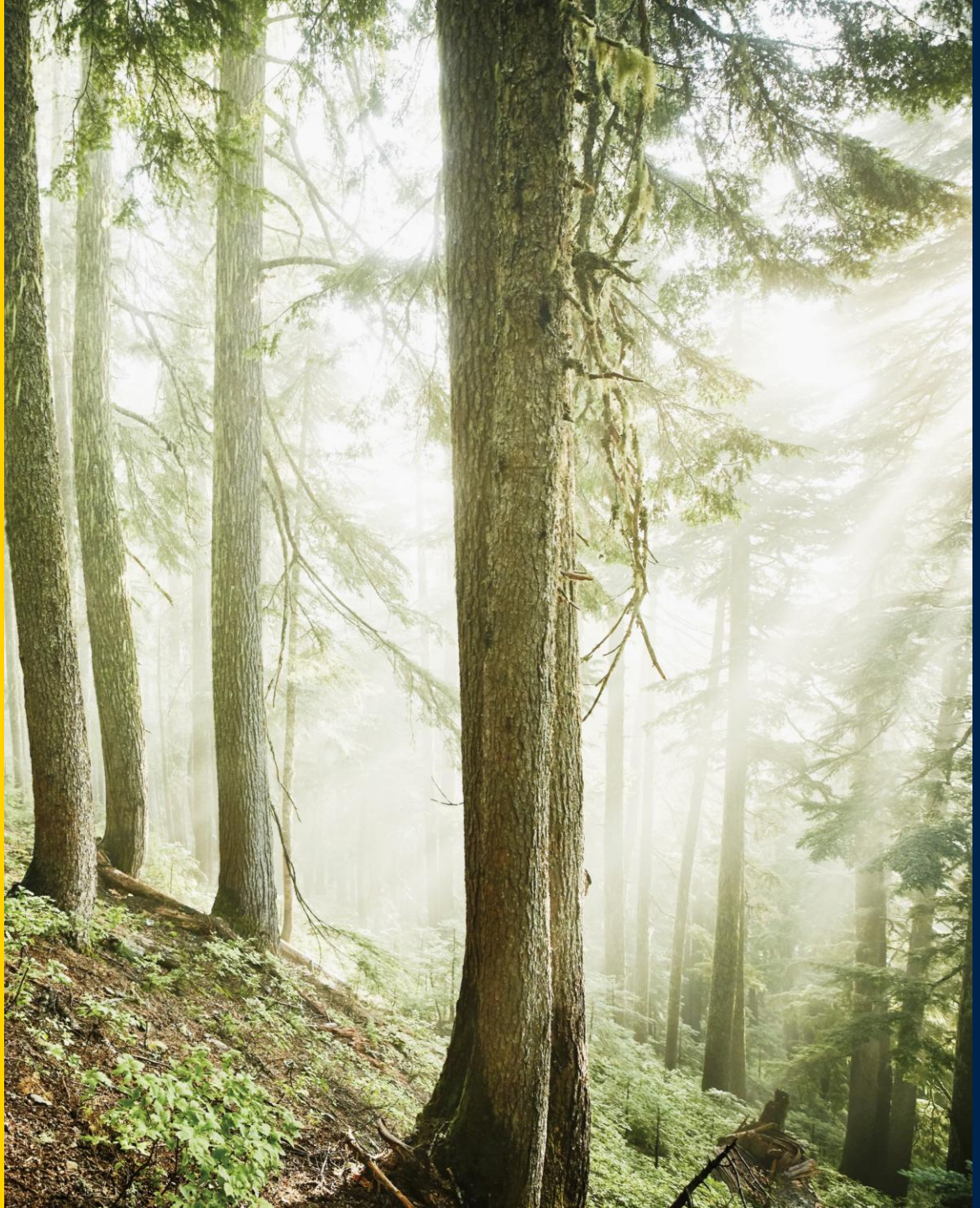


Power Device Solutions for Power Converters

Levin Liou
Power & Discrete MKT and Applications
Taiwan, APeC Region

AI data center infrastructure

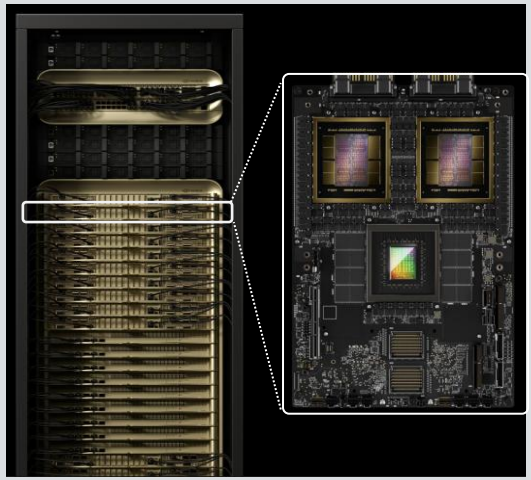
Power demand for NVIDIA GPU systems

5x more power is needed to drive the Rubin Ultra system!

NVIDIA Blackwell

Blackwell NVL36 (GPUx36)
- Total power: ~72 kW (18 kW x 4 shelves)

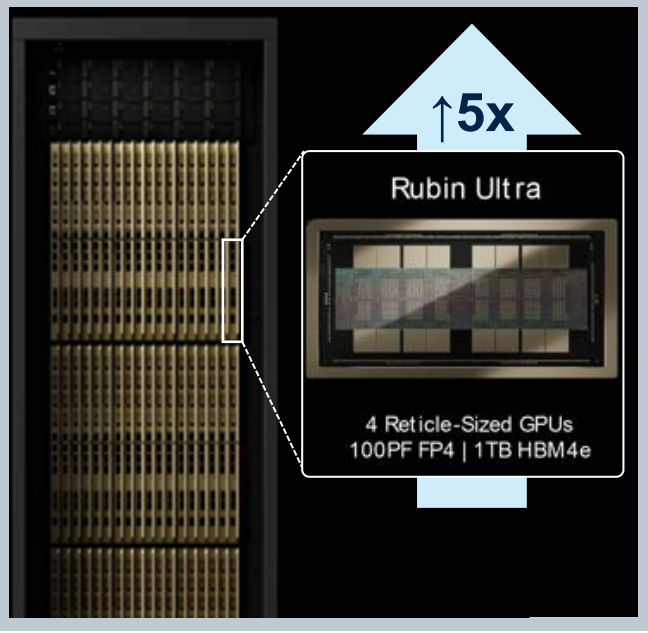
Blackwell NVL72 (GPUx72)
- Total power: ~132 kW (33 kW x 4 shelves)



NVIDIA Rubin

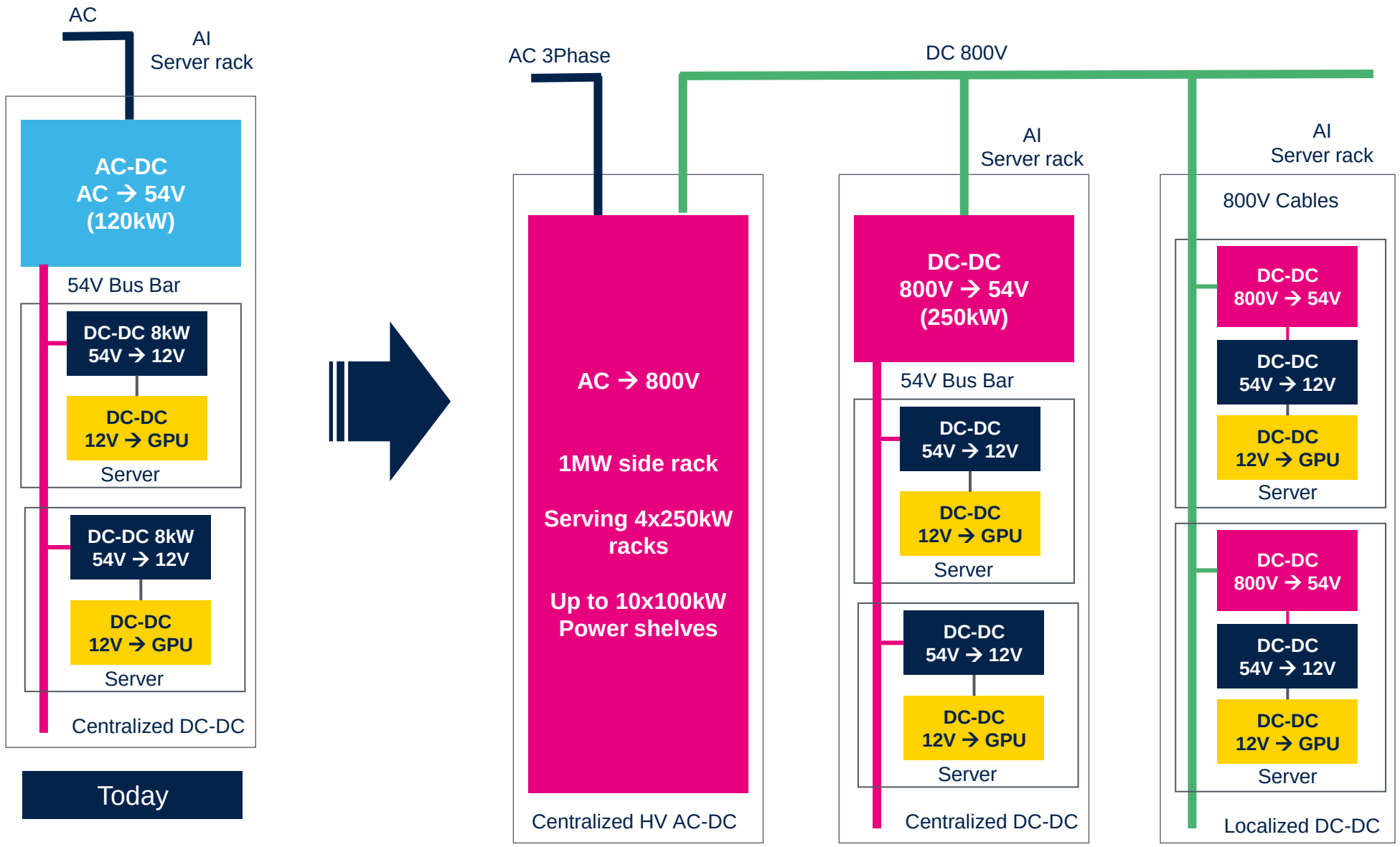
Vera Rubin NVL144 (GPUx144)
- Total power: ~264 kW (66 kW x 4 shelves)

Rubin Ultra NVL576 (GPUx576)
- Total power: >600 kW



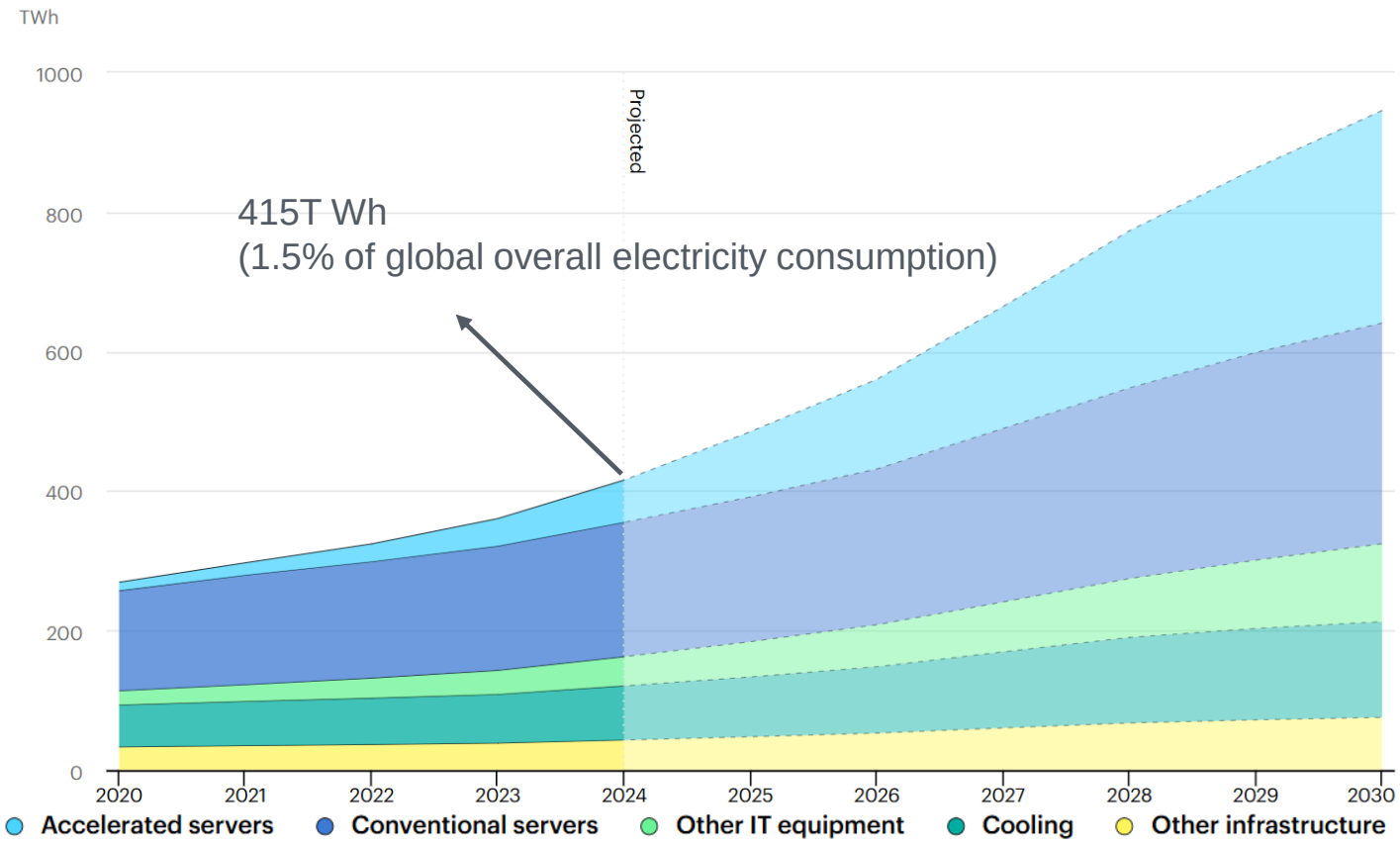
Source: NVIDIA

800V rack power delivery



Electricity consumption of global data center

1% efficiency improvement → 4.15 TWh energy saving



1% energy saving equals 4.15 TWh

~ 0.7 standard nuclear plants

2.43 MMBOe

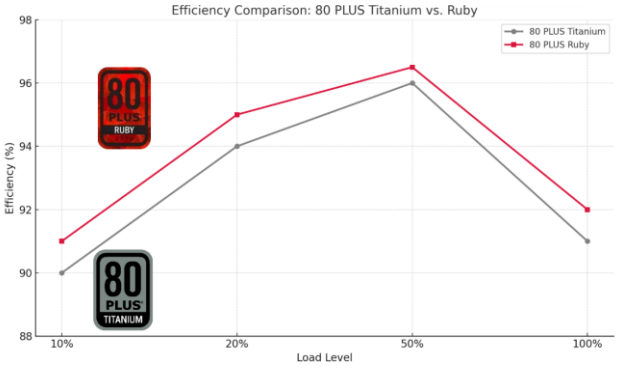
0.51 M tce

0.97 Tg CO_2

Source: International Energy Agency (IEA)

80 PLUS requirement for power supply

80 PLUS Certification	230V EU Internal Non-Redundant				230V Internal Redundant				
% of Rated Load	10%	20%	50%	100%	5%	10%	20%	50%	100%
80 PLUS	-	82%	85% PFC ≥ 0.90	82%	-	-			
80 PLUS Bronze	-	85%	88% PFC ≥ 0.90	85%	-	-	81%	85% PFC ≥ 0.90	81%
80 PLUS Silver	-	87%	90% PFC ≥ 0.90	87%	-	-	85%	89% PFC ≥ 0.90	85%
80 PLUS Gold	-	90%	92% PFC ≥ 0.90	89%	-	-	88%	92% PFC ≥ 0.90	88%
80 PLUS Platinum	-	92%	94% PFC ≥ 0.95	90%	-	-	90%	94% PFC ≥ 0.95	91%
80 PLUS Titanium	90%	94% PFC ≥ 0.95	96%	91%	-	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

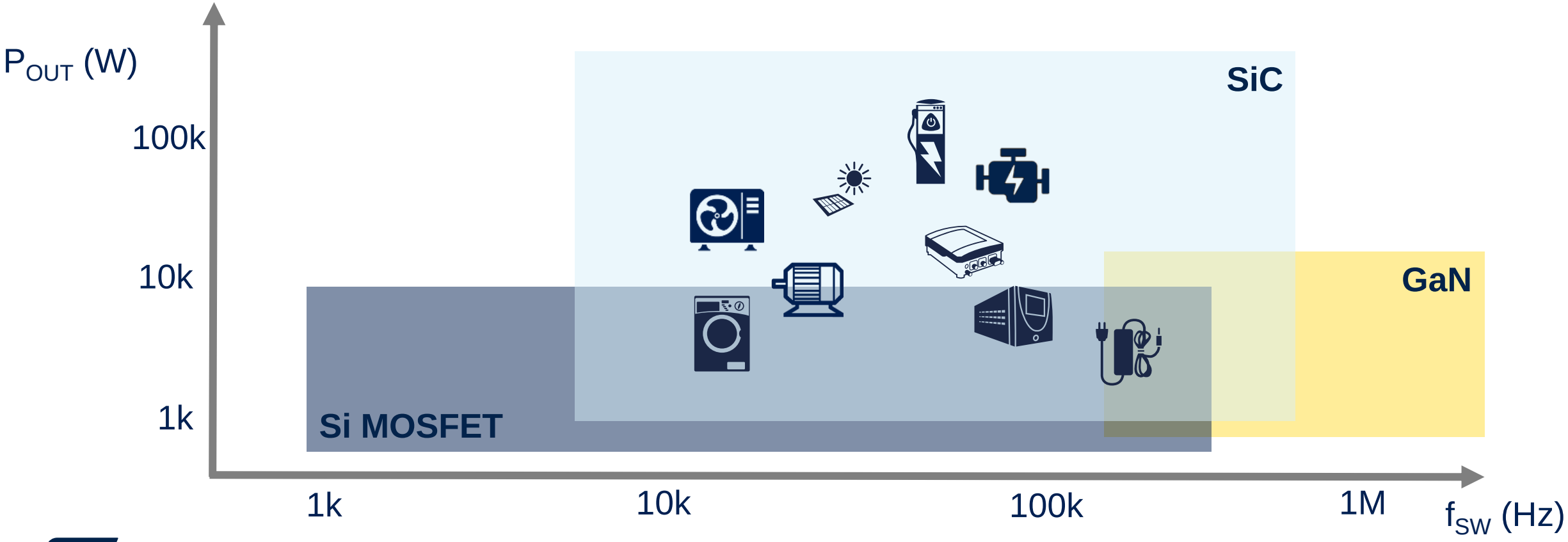


Source: CLEAResult

ST solutions for AI server application

Power semiconductor positioning vs key applications

A comprehensive range of power device solutions to address most power application requirements



ST silicon HV MOSFET roadmap

R_{DSON} 1 Ω 500 mΩ 300 mΩ 100 mΩ

M2/DM2
195 CPs

1.8 Ω — 40m Ω

Best performance / cost ratio

DM6
119 CPs

1.5 Ω — 36m Ω

Tailored for resonant topologies

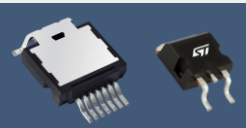
M5
81 CPs

0.6 Ω — 15m Ω

Tailored for hard switching

M9/DM9*
17CPs

160m Ω — 23m Ω

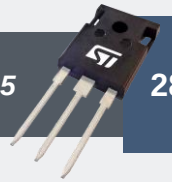


State-of-the-art in soft & hard switching

STMESH* Trench T/DT

In development

1ST CP in 2025



28m Ω

High density solution
For hard & soft switching

(*) More products under development

ST silicon carbide MOSFET midterm roadmap

Ron comparison vs previous generation at 1200 V, 25°C

Gen1 Optimized Ron and Tj for motor drive applications

Gen2 Balanced Ron and Qg for industrial and automotive
-50% $R_{DS(on)}$ x area

Gen3 Lower Ron vs Gen2 to maximize EV driving range
-30% $R_{DS(on)}$ x area

Gen4 For traction inverters & high-power ind.
-15% $R_{DS(on)}$ x area
750 V in full production
1200 V in development
2300 V and 3300 V subject to feasibility

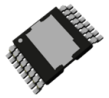
Enhanced planar technology

Full production – planar technology

Broad range of SiC discretes, bare dice, and modules


Bare die


TOLL

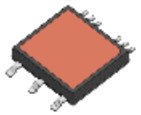

TOLT*


HiP247
3 & 4 leads


HU3PAK
(HC option*)


QDPAK*


STPAK

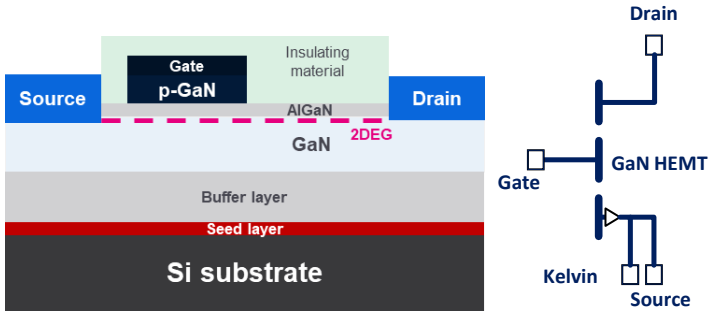

ACEPACK SMIT


ACEPACK 1 - 2 – 3*


ACEPACK DRIVE

ST PowerGaN roadmap

e-Mode (p-GaN)



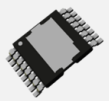
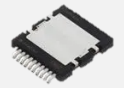
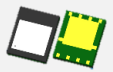
- Gan-on-Silicon normally-off based on p-GaN process
- Towards 8-inch wafers manufacturing with vertically integrated process: from GaN epitaxy to power device for LV/MV/HV
- Reliable supply chain
- Product differentiation through proprietary technology

2025 **Introduction** **2026** **In roadmap/development** **2027**

HV G-HEMT (700 V)	HV Bidirectional	VHV G-HEMT
RDSon 23 to 350 mΩ	650/900 V	900-1200 V

MV G-HEMT (100-200 V)	LV G-HEMT
RDSon 1.5 to 8 mΩ	30-60 V

Coupled with new performance packages

PowerFLAT 8x8 	DPAK 	TOLT 	QDPAK 
TOLL 	EN-FCLGA 5x6 	EN-FCLGA 3.3x3.3 	PowerFLAT 5x6 

Overview of ST solutions for AI server applications

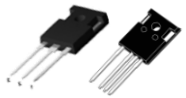
Si MOFET

650~1200 V

• M6/DM6 • M9/DM9 • Trench • F8(LV)

2025 | 2026 | 2027

TO-247 LL / TO247-4



- 23mΩ (650V)
- 28mΩ (600V, T)
- 29mΩ (600V, DT)

PowerFLAT 8x8 (600V/650V)

- 80mΩ (600V)
- 65mΩ (600V)
- 44/50/65mΩ (650V)

40~100 V

PowerFLAT 5x6 (40/100V)

- 3.2 mΩ (100V)
- 0.8 mΩ (40V)

TOLT (650V)

- 44/64mΩ

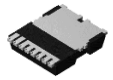
TO-LL (600V/650V)

- 54/82/125mΩ (600V)
- 30/32/45mΩ (600V)
- 33mΩ (650V)

PowerFLAT 5x6 (80V)

- 1.6/2.3 mΩ(80V)

TOLL (40V/80V/100V)



- 0.6mΩ (40V)
- 1.2mΩ (80V)
- 1.6mΩ (100V)

PowerFLAT 5x6 (80V/100V)

- 1.4mΩ (80V)
- 2.1 mΩ (100V)

QDPAK (600V)

- 17mΩ

LFPAL 5x7 TSC (40V/80V/100V)

- 1mΩ (40V)
- 2.2mΩ (80V)
- 3.5mΩ (100V)

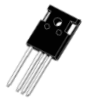
SiC MOSFET

650~1200 V

• Gen 3 • Gen 4

2025 | 2026 | 2027

HiP247-4 (650V)

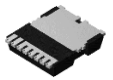


- 40 mΩ

H²PAK-7 (650V)

- 20/40/55 mΩ

TO-LL (650V)



- 14/27/40/55 mΩ

HiP247-4 (650V/750V/1200V)

- 14 mΩ (650V)
- 8mΩ (750V)
- 11mΩ (750V)
- 19/40/63mΩ (1200V)
- 9/11mΩ (1200V)

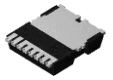
QDPAK HC (650V/750V/1200V)

- 14/18/40mΩ (650V)
- 8mΩ (750V)
- 9mΩ (1200V)

H²PAK-7 (1200V)

- 20/40/63 mΩ

TO-LL (650V)



- 10mΩ

GaN HEMT

650~1200 V

PowerGaN

2025 | 2026 | 2027

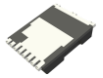
PowerFLAT 8x8 BSC (700V)

- 80/105/140/190/240mΩ

DPAK (700V)

- 350mΩ

TO-LL (700V)



- 70mΩ

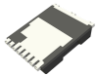
PowerFLAT 5x6 (700V)

- 100/130/240 mΩ

DPAK (700V)

- 240mΩ

TO-LL (700V)



- 32/55mΩ

TOLT (700V)

- 23mΩ

100 V

En-FCLGA (100V)

- 1.5mΩ
- 3.5mΩ

Bidirectional QDPAK (700V/900V)

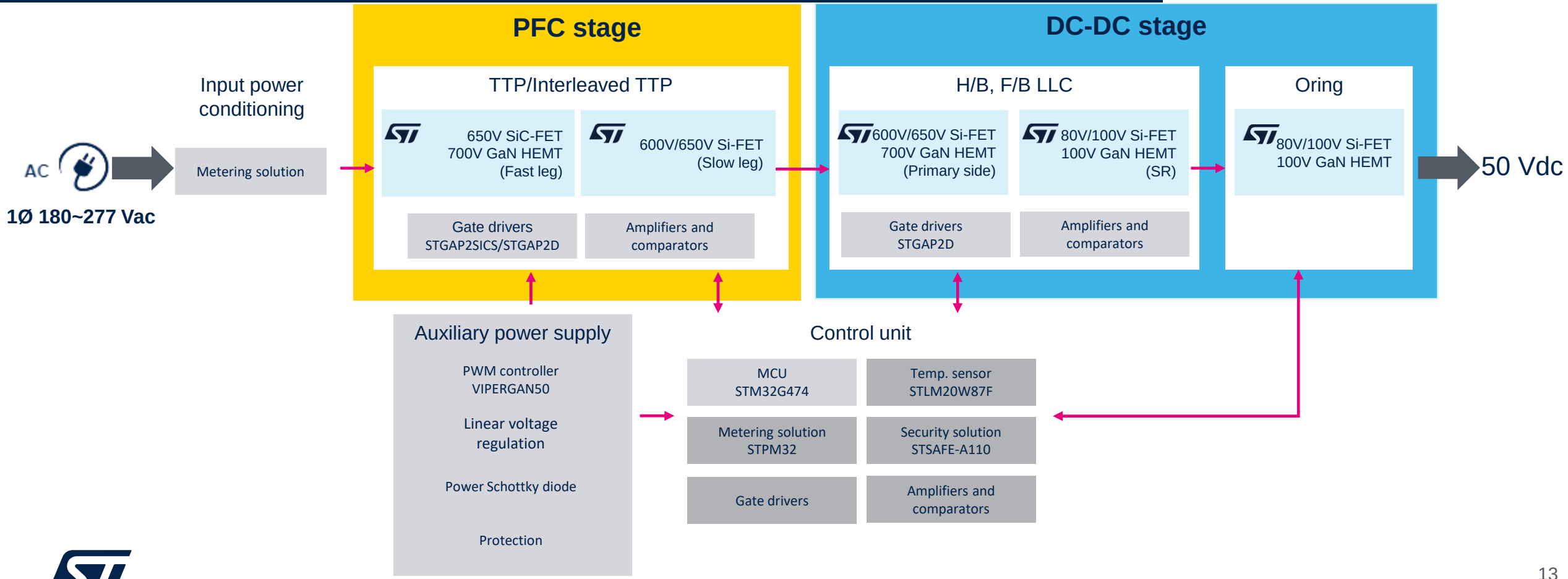
- 20mΩ (700V)
- 20mΩ (900V)

Bidirectional TOLT (700V)

- 140mΩ

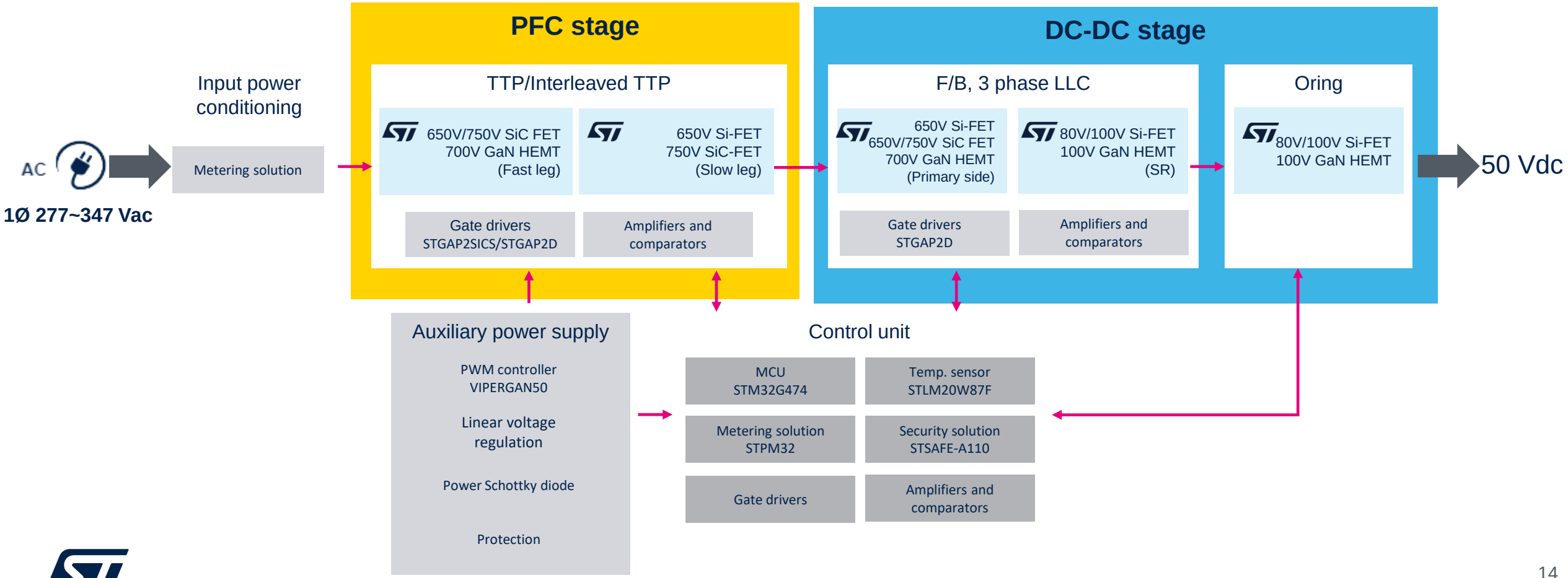
ST solutions for 3-8 kW PSUs in AI data centers

I/P: 1Ø 180-277 Vac O/P: 50 Vdc/3-8 kW



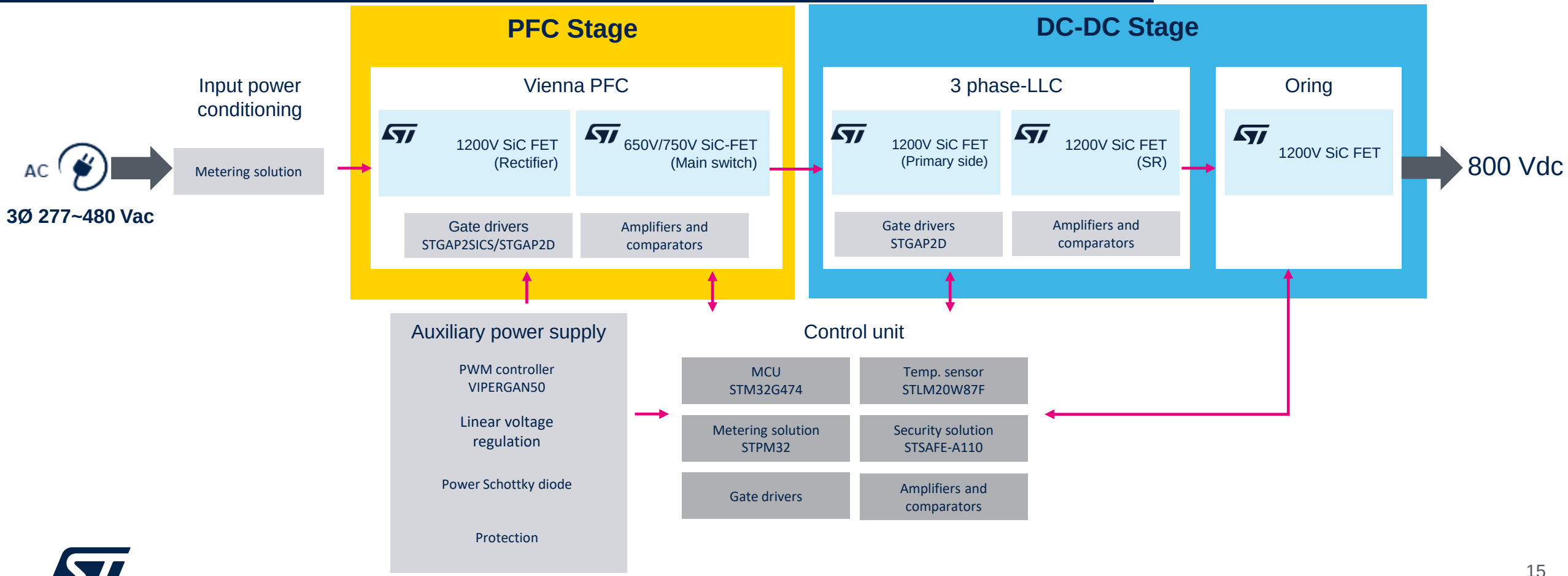
ST solutions for 8-12 kW PSUs in AI data centers

I/P: 1Ø 277-347 Vac O/P: 50 Vdc/8-12 kW

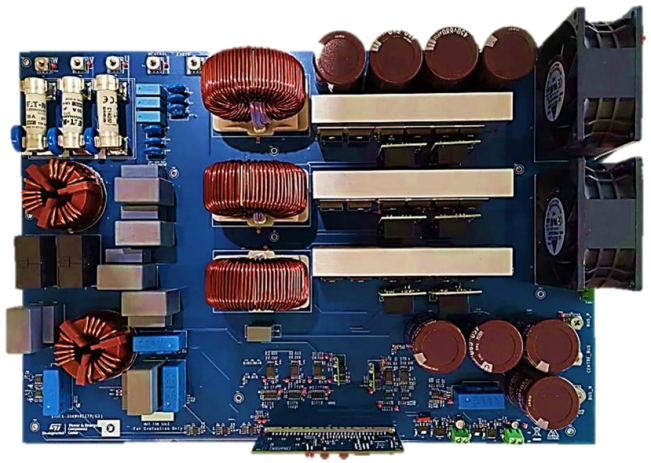


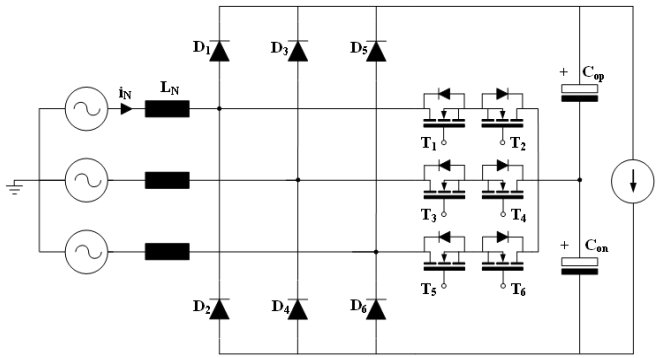
ST solutions for 12-30 kW 3-phase and HVDC converter in AI data center

I/P： 3Ø 277Vac~480Vac O/P: 800 Vdc/12-30 kW



30 kW three-phase Vienna rectifier





Key application specifications

1. Input AC voltage: three-phase 345 VAC up to 460 VAC with 47 Hz up to 63 Hz
2. Maximum input current: 55 Arms
3. DC Vout 800 VDC, rated output power **30 kW**, switching frequency 70 kHz
4. Peak efficiency **>98.7%**
5. 0.99 power factor with lower than 5% THD @ full load operation
6. STM32G474: high-performance 32-bit MCU

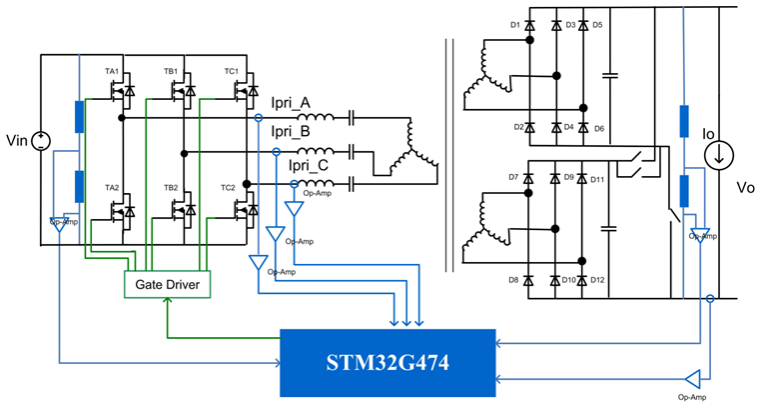
Key products

1. MCU: STM32G474RET3
2. SiC MOSFET: SCT018W65G3-4AG
3. SiC diode: STPSC40H12C
4. Gate driver: STGAP2SICS
5. Schottky diodes: STTH1L06A, STPS1150A, STPS2H100A, STPS2L60A
6. GPA: LD29080S33R, LD29080DT50R, TSV912IDT, TSV912IDT

Key benefits

- Solution based on SiC device; higher efficiency achieved
- Very low THD (total harmonic distortion)
- **Higher reliability**
- Low design complexity

30 kW three-phase LLC converter



Key application specifications

1. Rated output power: 30 kW, switching frequency 100-300 kHz
2. DC input voltage: 650 – 850 Vdc
3. DC output: 200 – 1000 Vdc
4. Peak efficiency >98%
5. STM32G474: high-performance 32-bit MCU

Key products

1. MCU: STM32G474VET6,
2. SiC MOSFET: SCT025W120G3-4AG
3. Ultrafast diode: STTH60RQ06W
4. ASP product: STGAP2SICS, L6565
5. Schottky diodes: STTH1L06A, STPS1150A, STPS2H100A, STPS2L60A
6. GPA: LM393DT, LD29080DT50R, LD29080DT33R, TSV9121DT

Key benefits

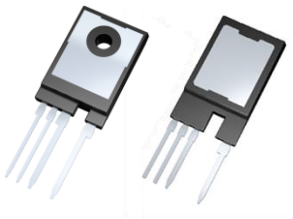
1. Higher efficiency with **1200 V** SiC device & high switching frequency
2. Less SiC MOSFET to achieve higher power with single LLC converter
3. Wide range and high output voltage

ST package solutions for AI server applications

ST package research and development

Increased power density through advanced package technologies

TO247-4 MAX247-4



TO247-4 HC
MAX247-4 HC

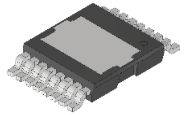
Very high voltage range

- 1200V voltage rated (TO-247 HCC)
- 1700V / 2200V voltage rated (MAX247 HCC)
- Sense pin for enhanced control
- High-creepage version
- Industrial Market

HU3PAK HC

OBC and DC-DC

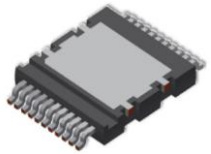
- 1700V voltage rated
- Sense pin for enhanced control
- High creepage version
- AEC-Q101 qualified, Tj (max)=175°C



TOLT

Server and SMPS

- 650V voltage rated
- Top side cooled
- Sense pin for enhanced control
- Creepage: 4.0mm
- 650 Vrms insulation in PD2



QDPAK HC

AI server OBC and DC-DC

- 650V / 1200V voltage rated
- Top side cooled
- Sense pin for enhanced control
- AEC-Q101 Rev.E

Features and benefits of HU3PAK

Top-side cooling package suitable for multiple switch topologies

Features

- AEC-Q101 qualified
- Tj (max) = 150°C
- Product offer up to 650 V
- Top-side cooling
- Kelvin source pin enables higher efficiency
- Low thermal resistance
- Reduced parasitic inductance and capacitance
- Total footprint 14 x 19 mm

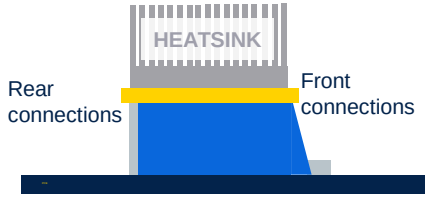
External pinout

Top view (heatsink side)

Bottom view (PCB side)

Benefits

- Improved thermal performances
- enables higher efficiency
- Suitable for several switch technologies
- Automotive graded

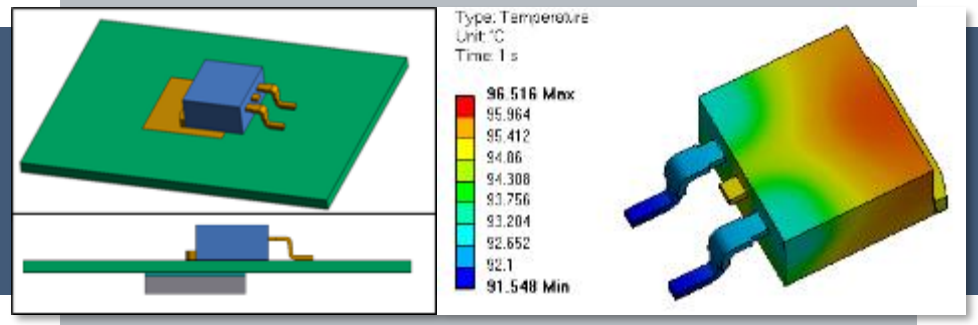


- Removing Rth element of the PCB ~20% Rth reduction
- Rth of 0.81C/W with water cooling

HU3PAK vs D2PAK
Thermal map @ full load

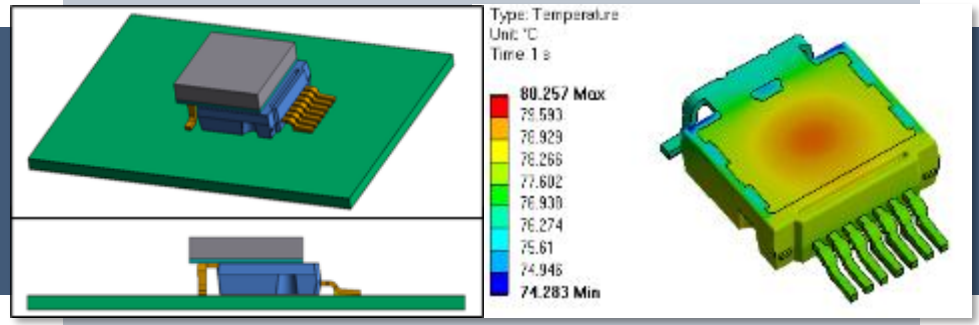
Top-side cooling solution improves heat dissipation capability keeping the same heat sink and PCB, allowing lower Tj

D²PAK bottom-side cooling



Same heatsink positioned on
- D²PAK bottom side of the PCB trough thermal vias
- HU3PAK directly on the top exposed copper frame

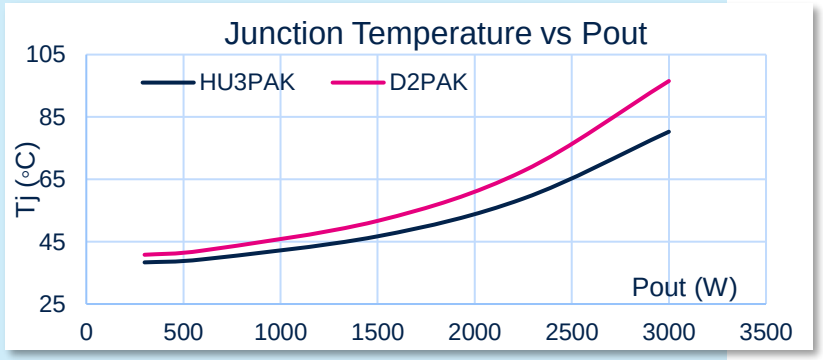
HU3PAK top-side cooling



	HU3PAK	D²PAK	
$R_{th(J-H)}$(K/W)	8.91	10.47	**-15%**
$R_{package}$(mΩ)	80	80	//

Losses in 3kW FB LLC

	D²PAK	HU3PAK	
P_{die} (W)	0.578	0.568	@ Pout 300 W
T_j(°C)	40.7	38.4	**-2.3°C**
P_{die} (W)	5.908	5.275	@ Pout 3 kW
T_j(°C)	96.52	80.26	**-16.26°C**



The coldest device works with lower RDS(on) lowering the conduction losses

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