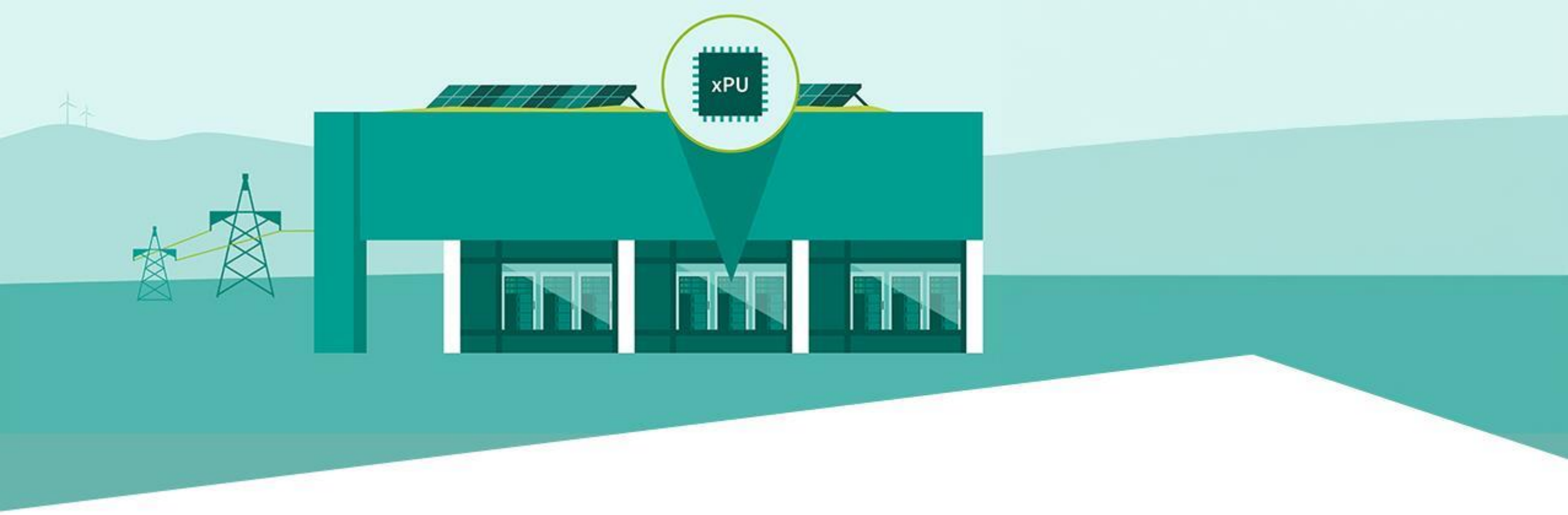


Battery backup and capacitor bank units for AI datacenters

Filippo Rosetti (Application Marketing for BBU and CBU)
Rafael Garcia Mora (System Architect for BBU and CBU)

Public

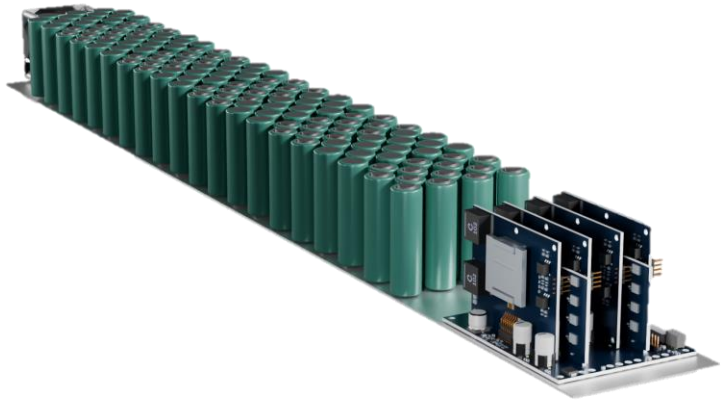
AI server rack and BBU trends



BBU is evolving with more power and more battery cells in the modules, allowing less space for the DC-DC converter

Battery Backup Unit

Battery Backup Unit (BBU): Backup power system that guarantees AI datacenter uptime and prevents data loss during AC power outages, formed by DCDC and BMS



Capacitor Bank Unit (CBU) / Power Capacitance Shelf (PCS)

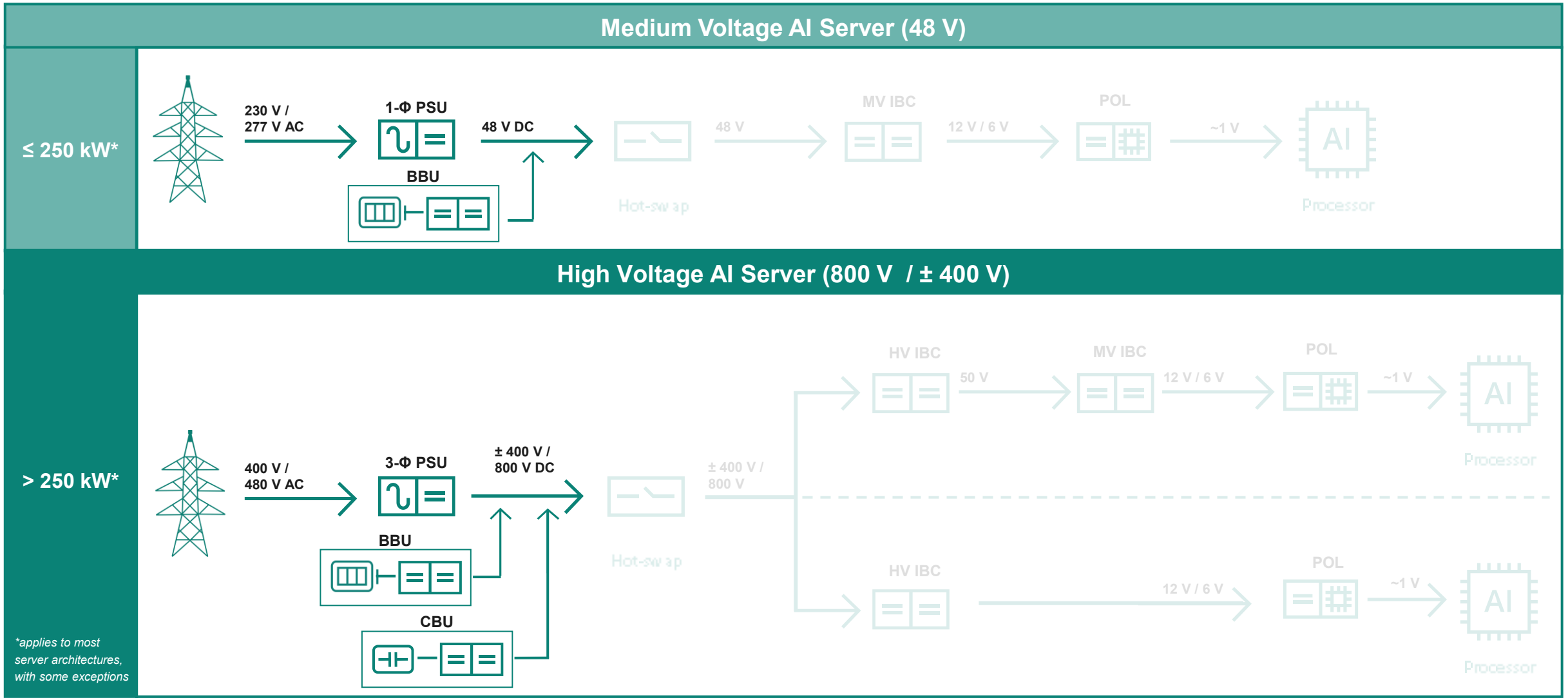
A power optimization solution that uses either EDLC or supercapacitors to smooth out power demand (peak power shaving) from GPU+CPUs. Reduces disturbance impact in the AC grid and improve datacenter reliability.



Capacitor Bank Unit (Li-ion / EDLC supercap)	Battery Backup Unit (LFP batteries)	Uninterruptable Power Supply	BESS	Generator (Diesel)
Peak power range: 50ms ~ 10s	Back-up time range: 90 ~ 240s	UPS Back-up time range: ms ~ min	Back-up time range: min ~ hours	Back-up time range: hours ~ days

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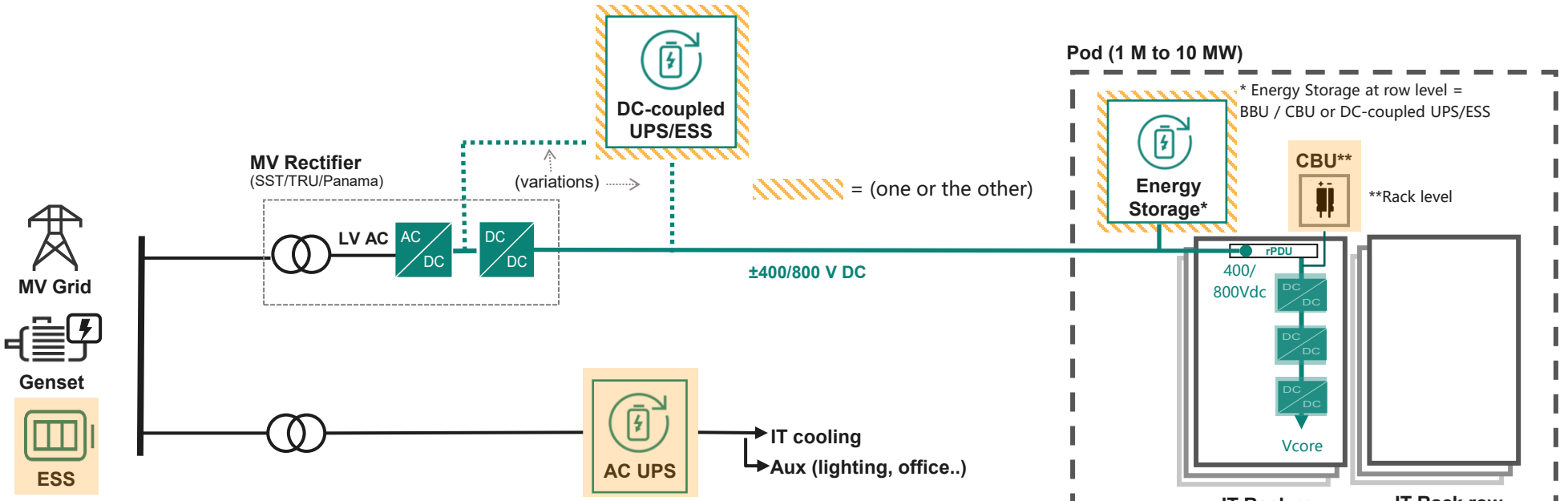
The PSU and the BBU share the same power and are positioned close to each other



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Power delivery in AI data centers

in 2028+ BBU racks as Energy Storage on the DC line, while CBU will cope with peak power demands next to the IT rack



- DC power distribution now provided by MV rectifiers, like SSTs
- UPS becomes DC-coupled to the 800Vdc bus, 2-5MVA
- Alternatively, UPS/ESS/BBU could be directly coupled with the SST or MV Rectifier
- Pod-level backup in the form of BBU / CBU or DC-coupled UPS/ESS is also possible
- Auxiliary AC loads still need to be handled separately

= AC
= DC
= Energy storage

ESS: energy storage system, **UPS**: uninterruptable power supply, **PDU**: power distribution unit, **BBU**: Battery Backup Unit,, **TRU**: Transformer-Rectifier Unit, **SST**: Solid State Transformer

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Architecture and topologies



The Battery Backup Unit and Capacitor Bank Unit have the following key functional blocks

Protection

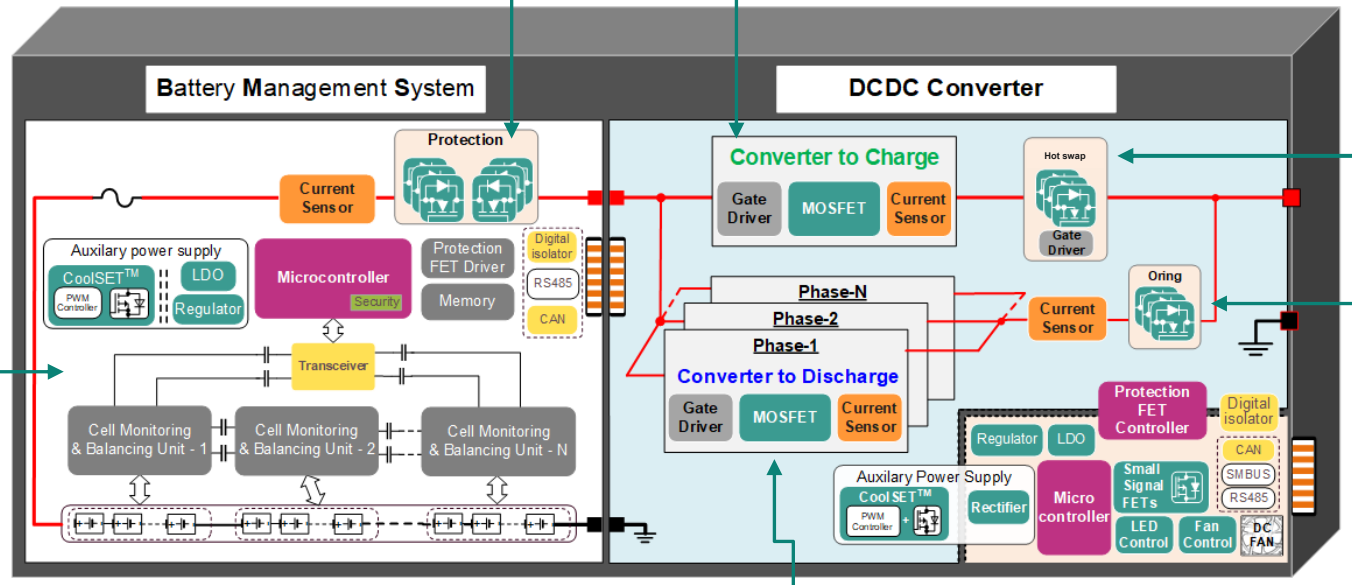
- Protects battery / capacitors from abnormal situations

DC-DC Converter for charging

- Charges battery
- For BBU the rating is ~10% of discharging rate

Hot-swap

- Avoids large and uncontrolled currents when plugging in the BBU / CBU unit into the rack
- Controls the inrush current and regulate the charging current of the internal capacitors



BMS/CMS

- Monitors voltage, current & temperature of cells
- Estimates SoC, SoH, DoD, etc.
- Optimizes performance

DC-DC Converter for discharging

- For BBU, 90~120s full power, 240s at de-rated power
- Power ratings for BBU are equivalent to PSU rating (18 kW to 30 kW)
- CBU covers the GPU peak power demands at DC bus level from PSU´s 110% rating upwards. For CBU same topology for charging

ORing

- Avoids reverse current flow into BBU / CBU
- Ensures current sharing between parallel modules
- Protects the rest of the modules in case abnormal situation with its converter

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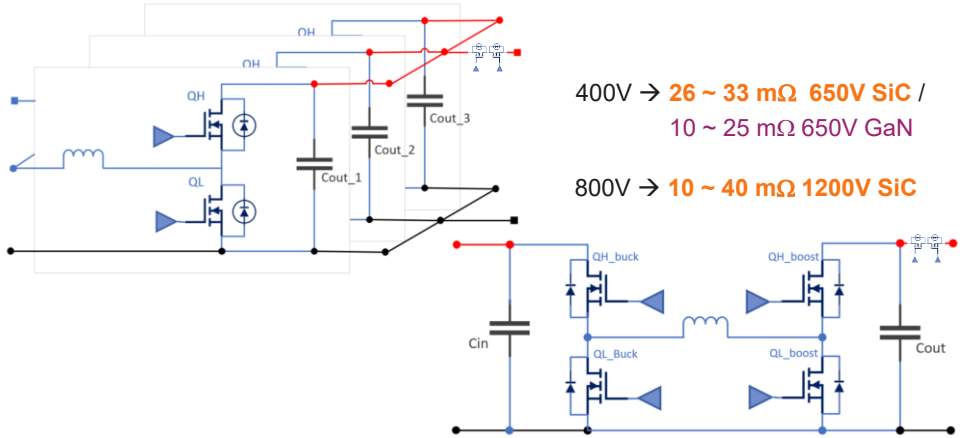
DC-DC Topology selection for HV BBU and CBU converters

Bidirectional power flow using non-isolated and isolated topologies

Conventional topologies

Non-isolated

Boost / Buck converter, e.g. interleaved / 4SW Buck and Boost

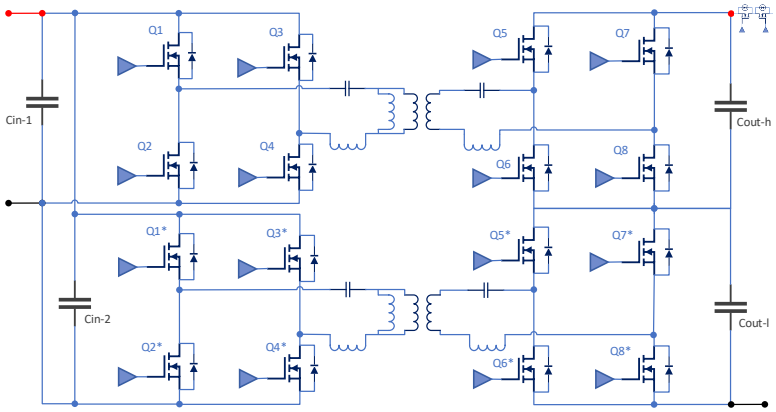


400V → **26 ~ 33 mΩ 650V SiC** /
10 ~ 25 mΩ 650V GaN

800V → **10 ~ 40 mΩ 1200V SiC**

Isolated

Resonant / Soft Switching converter, e.g. LLC / SRC

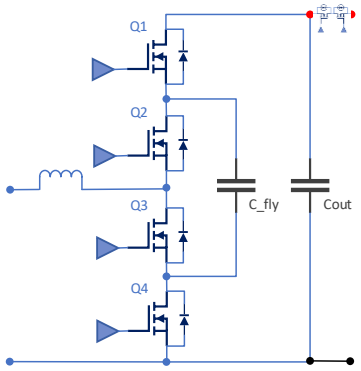


400V - 2L **15 ~ 26mΩ 650V SiC** /
10 ~25 mΩ 650V GaN

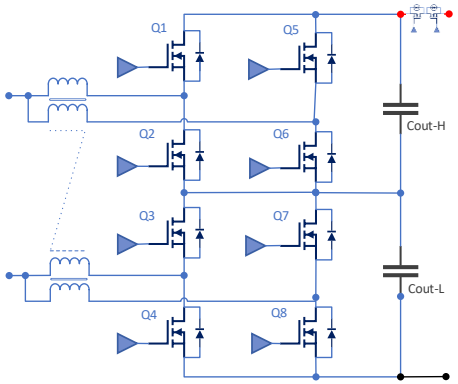
800V - 3L **10 ~25 mΩ 650V GaN** /
15 ~ 26mΩ 650V SiC /
- 2L **26 ~ 33 mΩ 1200V SiC**

Emerging topologies

3-Level Boost - Buck converter, e.g. Flying cap / stacked



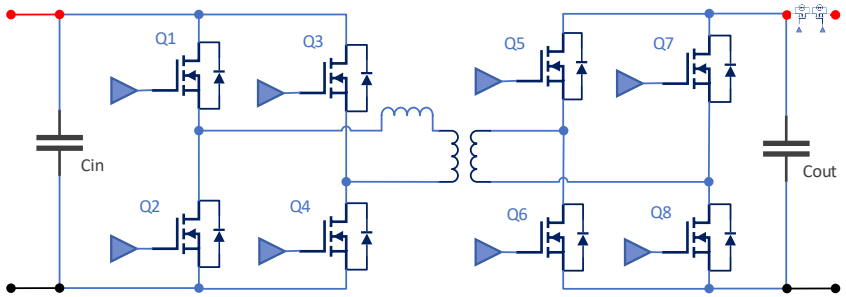
800V → **20 ~ 26mΩ 650V SiC**
17 mΩ 650V GaN



800V → **26 ~ 33 mΩ 650V SiC**
17 mΩ 650V GaN

400V Oring → **5 ~ 9 mΩ 650V/750 SiC**

ZVS phase shift modulation DC-DC converter, e.g. DAB



400V → **20 ~ 26mΩ 650V SiC** / **10 ~17 mΩ 650V GaN**
800V → **26 ~ 33 mΩ 1200V SiC**

800V Oring → **10 ~ 22 mΩ 1200V SiC**

SiC GaN

Bold means preferred **technology**

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Value proposition of Infineon's products in server BBU & CBU



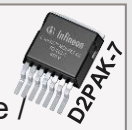
Infineon's offerings to HV (±400 V/800 V) DC-DC converter

DC-DC converter

MOSFETs

CoolSiC™ G2

- ≥ 7mΩ, 650 V Low $R_{DS(on)}$ for best price / performance
- Lower $R_{DS(on)}$ and switching losses
- Robust against parasitic turn-on
- .XT tech. for thermal performance







GaN HEMTs

CoolGaN™ ≥ 25 mΩ, 650 V

- High power density & efficiency
- Ultrafast switching
- No reverse recovery charge





Gate Drivers

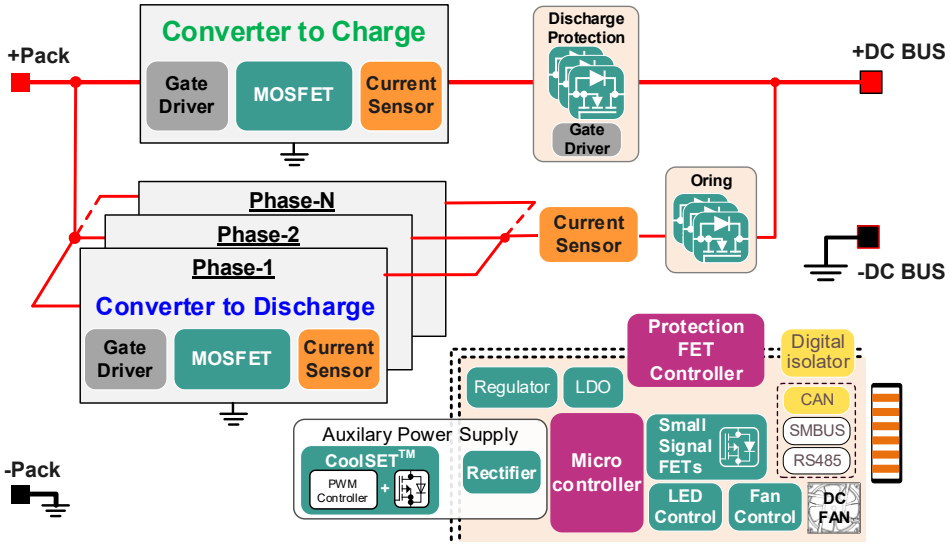
EiceDRIVER™

- ≤6 A Single and dual channel driver
- Isolated and non-isolated driver
- Strong source/sink current capability
- Compatible for GaN SG HEMTs and MOSFET





DC-DC charger or discharge



Microcontroller

PSOC™ C3

- ≤180 MHz, 48, 64, 80 pins packages
- Faster ADC: 12 Msps
- < 100 ps high resolution PWM



Current sensors

XENSIV™

- High bandwidth (5 MHz)
- High precision
- Cost effective
- Compact

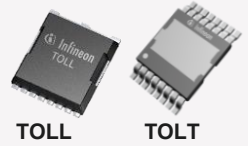


Protection MOSFETs

MOSFETs

CoolMOS™8; CoolSiC™ G2, CoolSiC™ JFET; CoolSiC™ JFET Cascode

- Low $R_{DS(on)}$
- Differentiating & industry standard packages
- 1200 V for 800 V bus configuration
- 750 V for 400 V bus configuration

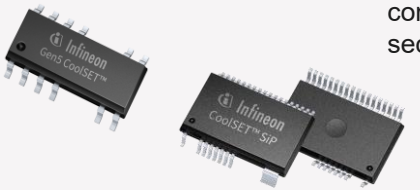
CoolSET™ AC-DC integrated power stages

ICE5QR1680

- <40 W Aux Power supply
- Topology: Flyback QR & FF
- 700 V/800 V P7 CoolMOS™ integrated

ICE18XEM

- **30~100 W** Aux power supply
- Topology: Flyback QR ZVS up to 150 KHz
- Primary controller + MOSFET + isolated communication + secondary controller



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Infineon's high voltage BMS solution covering a wide range of products to provide a total system offering

BMS Products

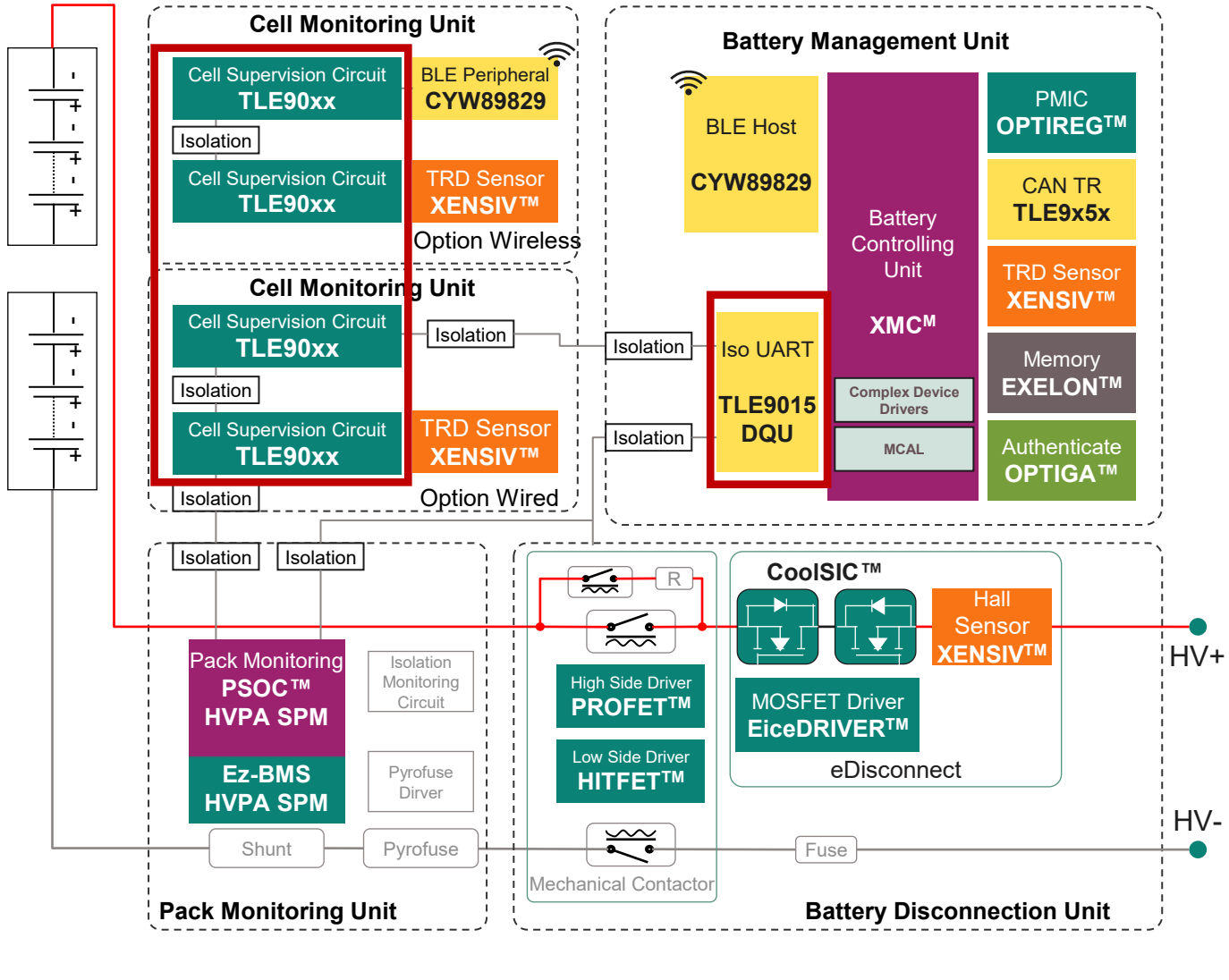
BMS specific products
- **TLE90xx** up to 18 channel ASIL-D BMS cell balancing and sensing IC
- **PSOC™ HVPA/ Ez-BMS** accurate ASIL-C & D pack monitoring device

Wired BMS specific products
- **TLE9015DQU** Dual channel UART to iso-UART transceiver

Wireless BMS specific products
- **CYW89829** Automotive BLE 5.4 SoC

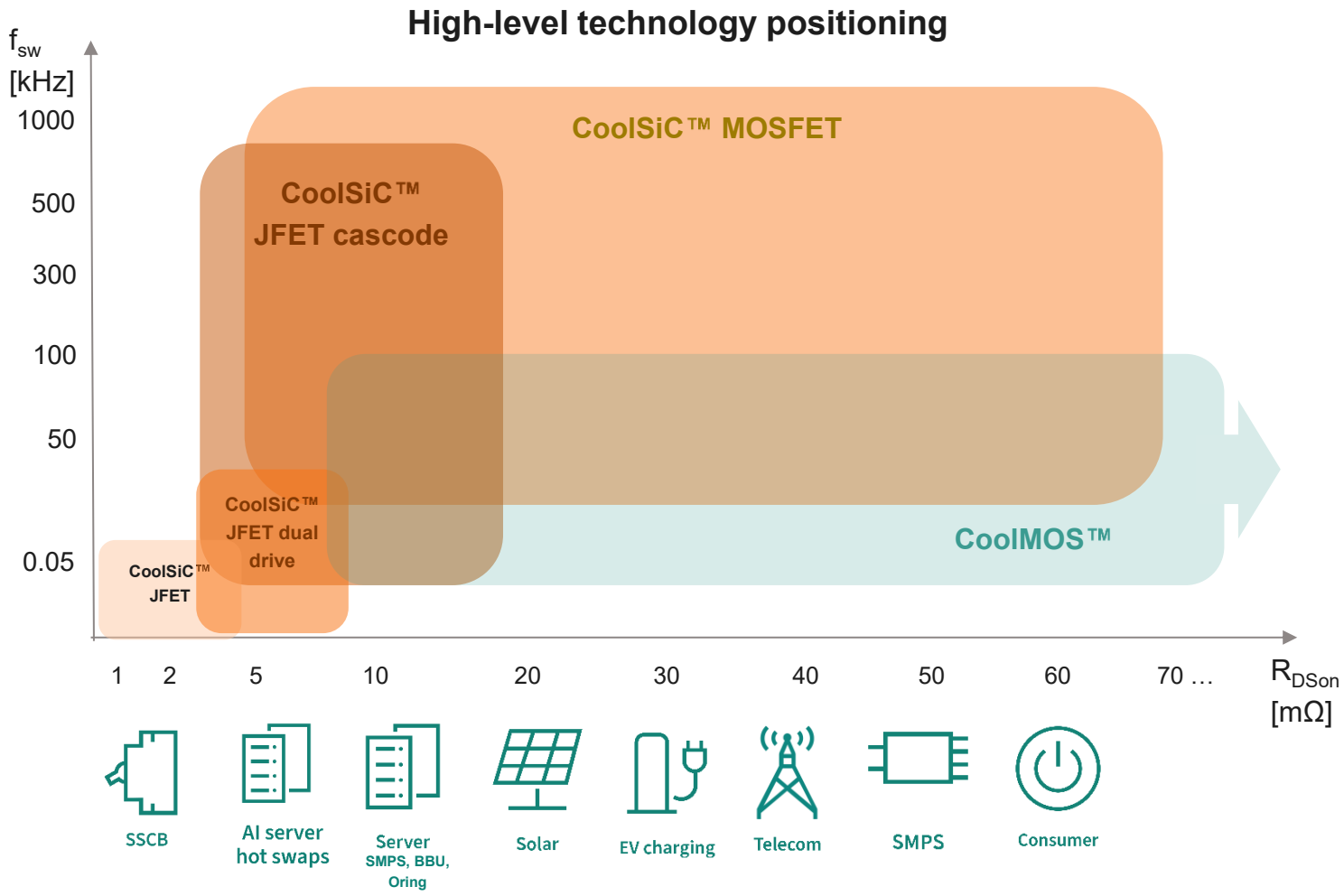
Standard products

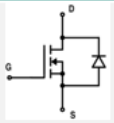
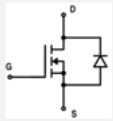
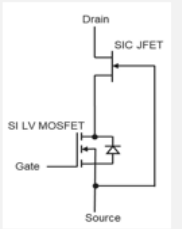
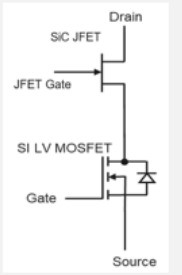
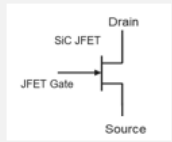
- **XMC™** CYT2x, CYT4x
- **CoolSET™** Power Supply controller IC
- **OPTIREG™** TLF3x/TLF4x PMIC
- **TLE9x5x** CAN Transceiver
- **KP2x, KP4x** Pressure sensor
- **TCIx** Hydrogen sensor
- **PROFET™** High-side smart switch
- **HITFET™** Low-side smart switch
- **CoolSiC™** MOSFETs up to 1200 V
- **OptiMOS™** MOSFETs up to 150 V
- **EiceDRIVER™** HV gate drivers
- **Excelon™** FRAM non-volatile RAM



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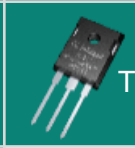
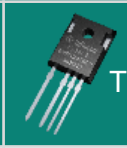
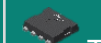
Different technology positioning across focus applications based on Rds(on)



Technologies' main values			
CoolMOS™		› Price/performance ratio › 12V gate driving	Various applications
CoolSiC™ MOSFET		› Ease of use › Controllability › Best in class FOMs, lowest Q_{OSS} › Low temp. coefficient	Various applications
CoolSiC™ JFET cascode		› BiC normally-off SiC › SC robustness › 12V gate driving › Low Vsd	Server SMPS, BBU AI server BBU
CoolSiC™ JFET dual drive		› BiC normally-off SiC › Large SOA › Gates for JFET and LV-MOSFET accessible for feedback control › Possible JFET overdrive	AI server hot swaps SSCB
CoolSiC™ JFET		› Lowest Ron x A for static applications › Ruggedness	SSCB

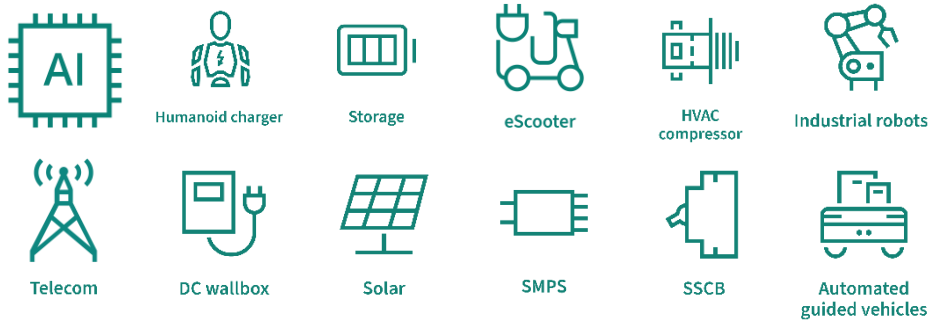
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CoolSiC™ MOSFETs 650 V Gen 2 Industrial grade

Cooling		THD Package		SMD Bottom Side Cooling			SMD Top Side Cooling - 2,3 mm height	
$R_{DS(on)}$ max [mΩ] 18 V	$R_{DS(on)}$ typ [mΩ] 18 V	 TO-247-3	 TO-247-4	 D2PAK-7	 TOLL	 Thin-TOLL 8x8 leadless	 TOLT	 Q-DPAK
95	75	IMW65R075M2H	IMZA65R075M2H	IMBG65R075M2H	IMT65R75M2H	IMTA65R075M2H	IMLT65R075M2H	
75	60	IMW65R060M2H	IMZA65R060M2H	IMBG65R060M2H	IMT65R060M2H	IMTA65R060M2H	IMLT65R060M2H	
62	50	IMW65R050M2H	IMZA65R050M2H	IMBG65R050M2H	IMT65R050M2H	IMTA65R050M2H	IMLT65R050M2H	
49	40	IMW65R040M2H	IMZA65R040M2H	IMBG65R040M2H	IMT65R040M2H	IMTA65R040M2H	IMLT65R040M2H	
42	33	IMW65R033M2H	IMZA65R033M2H	IMBG65R033M2H	IMT65R033M2H	IMTA65R033M2H	IMLT65R033M2H	
33	26	IMW65R026M2H	IMZA65R026M2H	IMBG65R026M2H	IMT65R026M2H	IMTA65R026M2H	IMLT65R026M2H	
24	20	IMW65R020M2H	IMZA65R020M2H	IMBG65R020M2H	IMT65R020M2H	IMTA65R020M2H	IMLT65R020M2H	IMDQ65R020M2H
18	15	IMW65R015M2H	IMZA65R015M2H	IMBG65R015M2H	IMT65R015M2H		IMLT65R015M2H	IMDQ65R015M2H
13	10	IMW65R010M2H	IMZA65R010M2H	IMBG65R010M2H	IMT65R010M2H			IMDQ65R010M2H
8	7	IMW65R007M2H	IMZA65R007M2H	IMBG65R007M2H				IMDQ65R007M2H

Benefits

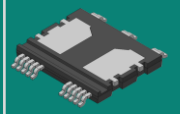
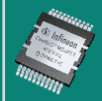
- ✓ 5~20% lower power losses over G1
- ✓ Extended driving rage from -7 V to +23 V static
- ✓ **Simpler unipolar driving**
- ✓ Superior energy efficiency and power system density
- ✓ **66% lower parasitics with Top Side Cooling**



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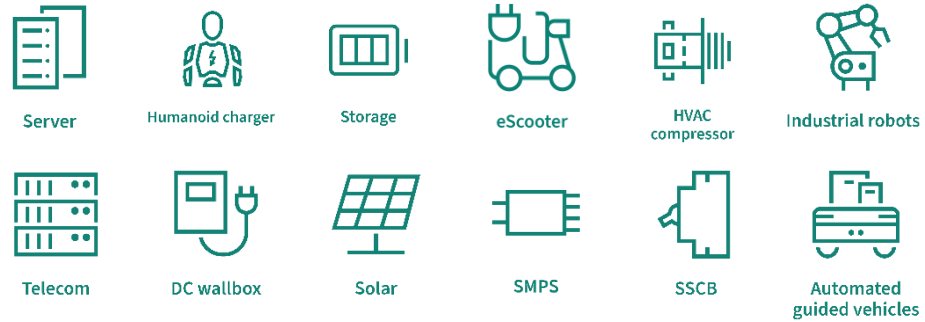
CoolSiC™ MOSFETs 750 V Gen 2 Industrial grade

Products in development stage - Portfolio and timelines subject to change.

Cooling		THD Package	SMD Bottom Side Cooling	SMD Top Side Cooling- 2,3mm height		
$R_{DS(on)}$ max [mΩ] 18 V	$R_{DS(on)}$ typ [mΩ] 18 V	 TO-247-4	 D2PAK-7	 Q-DPAK	 Hexa-DPAK Half-bridge Dual-switch	 Q-DPAK Bi-directional Dual-switch
75	60	IMZA75R060M2H	IMBG75R060M2H	IMDQ75R060M2H		
62	50	IMZA75R050M2H	IMBG75R050M2H	IMDQ75R050M2H		
49	40	IMZA75R040M2H	IMBG75R040M2H	IMDQ75R040M2H		IMDQ75B040M2H
42	33	IMZA75R033M2H	IMBG75R033M2H	IMDQ75R033M2H	IMSH75H033M2H	IMDQ75B032M2H
33	26	IMZA75R025M2H	IMBG75R025M2H	IMDQ75R025M2H	IMSH75H025M2H	
24	20	IMZA75R020M2H	IMBG75R020M2H	IMDQ75R020M2H	IMSH75H020M2H	IMDQ75B022M2H
18	15	IMZA75R016M2H	IMBG75R016M2H	IMDQ75R016M2H	IMSH75H016M2H	IMDQ75B014M2H
13	10	IMZA75R011M2H	IMBG75R011M2H	IMDQ75R011M2H	IMSH75H011M2H	
8	7	IMZA75R007M2H	IMBG75R007M2H	IMDQ75R007M2H	Q1/27	Q4/26
5	4			IMDQ75R004M2H		

Benefits

- ✓ Highly robust 750V technology + T_{vj}=200°C for 100h
- ✓ **100% avalanche tested**
- ✓ Superior energy efficiency and power system density
- ✓ **Dual-switch portfolio to enable innovation**
- ✓ **66% lower parasitics with Top Side Cooling**



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CoolSiC™ JFET cascode and dual drive portfolio

RDS(on,typ) @25C [mΩ]	CoolSiC™ JFET cascode		CoolSiC™ JFET dual drive		
	TOLL 750V 	Q-DPAK 750V 	TOLL 750V 	Q-DPAK 750V 	Q-DPAK 1200 V 
3.x		★		★	
4.x	★	★	★	★	★
5.x	★	★	★	★	★
8.x	★	★	★	★	
11	★				
~ 20					★
Samples	Available				
SOP	2027				

Products in development stage - Portfolio and timelines subject to change

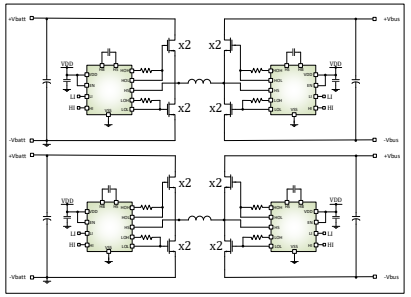
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Why is CoolGaN™ the perfect solution for 50 V high power design?

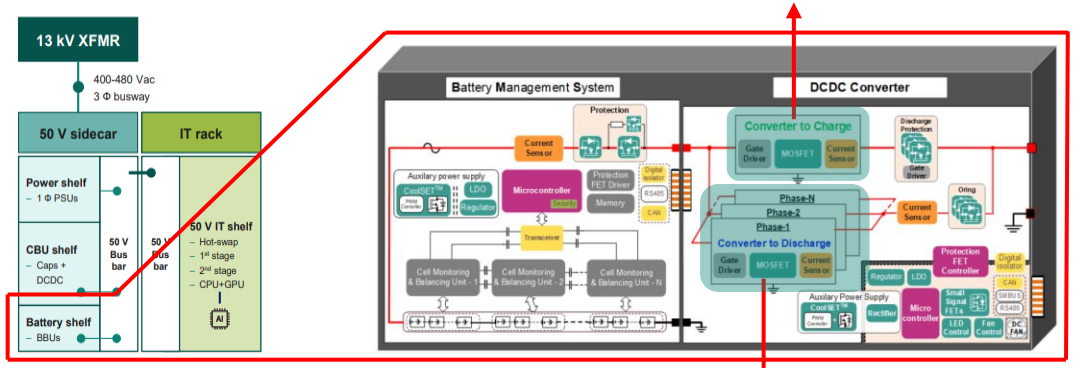
Key features	Benefits	Value for the customer
Lower $R_{DS(on)}$ compared to Si MOSFET	– Low conduction losses – Low switching losses – Fast turn on and off – Less paralleling required – RoHS compliance, lead free	High power density
Significantly improved FOMs compared to Si MOSFET: – Q_g = -66% – Q_{oss} = -35% – Q_{rr} = -100%		High efficiency
Optimized for high switching frequency applications		
MSL 1 classified according to J-STD-020		High system reliability

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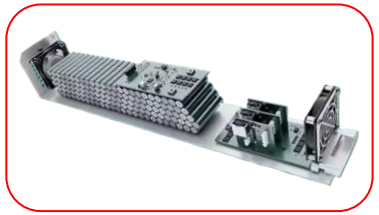
EiceDRIVER™ 2EDL501XAA-U2D is optimized for high performance operation of MV GaN HEMTs in BBU converters



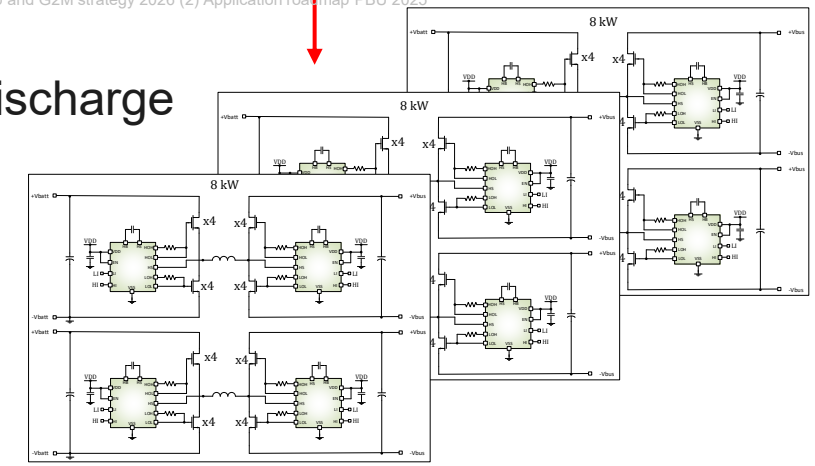
Charge



Source diagrams: From (1) Server PSU application roadmap and G2M strategy 2026 (2) Application roadmap PBU 2025



Discharge



Key features	System benefits
Strong output stage	Capability to drive several switches in parallel without sacrificing system efficiency
Low bootswitch resistance	Low bootswitch voltage drop for symmetrical LS and HS driving voltage even with several switches in parallel
Active miller clamp	Protection against induced turn-on caused by high dv/dt and eliminates the use of negative gate bias
-5 V HS capability	Reliable operation with MV GaN during deadtime where the MV GaN's V_{SD} can go beyond -3 V
100 V/ns HS slew rate capability	Robust operation against high dv/dt in hard-switching and high-power application

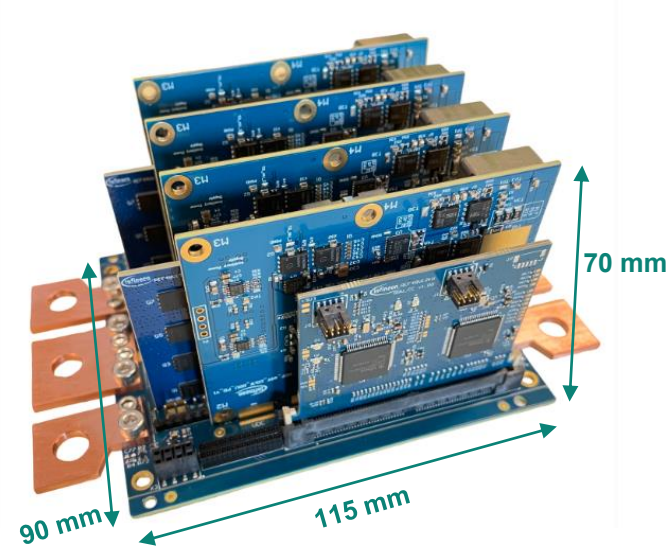
EiceDRIVER™ 2EDL501xAA is an right solution for hard switching and high power BBU applications with its high slew rate, low bootswitch resistance and strong drive capability

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System application boards



BBU 50 V, 12 kW Reference Design



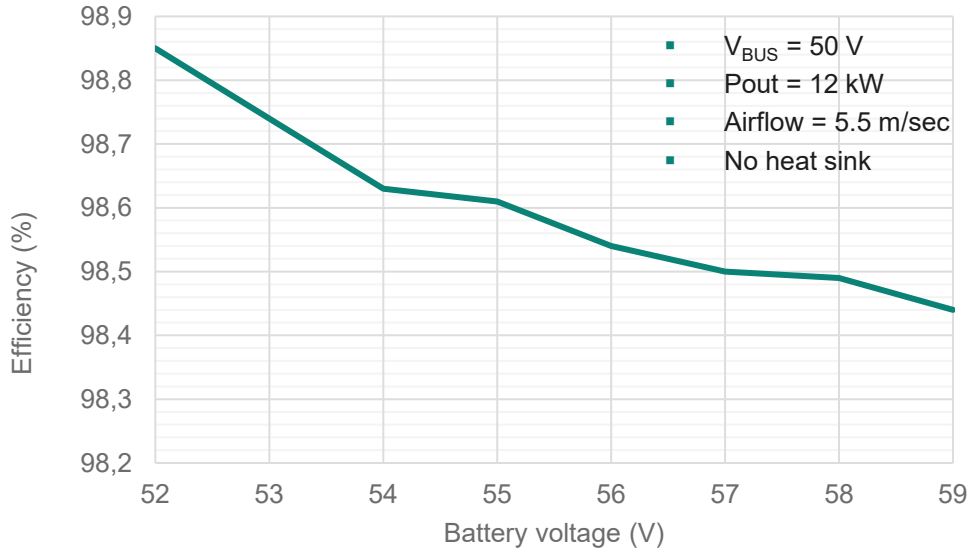
12 kW Board consists of

- 4x Power card – (3 kW rated power each)
- 1x Controller card – 2x PSoC™ C3 MCUs
- 2x Protection/ORing card
- 1x Main Board

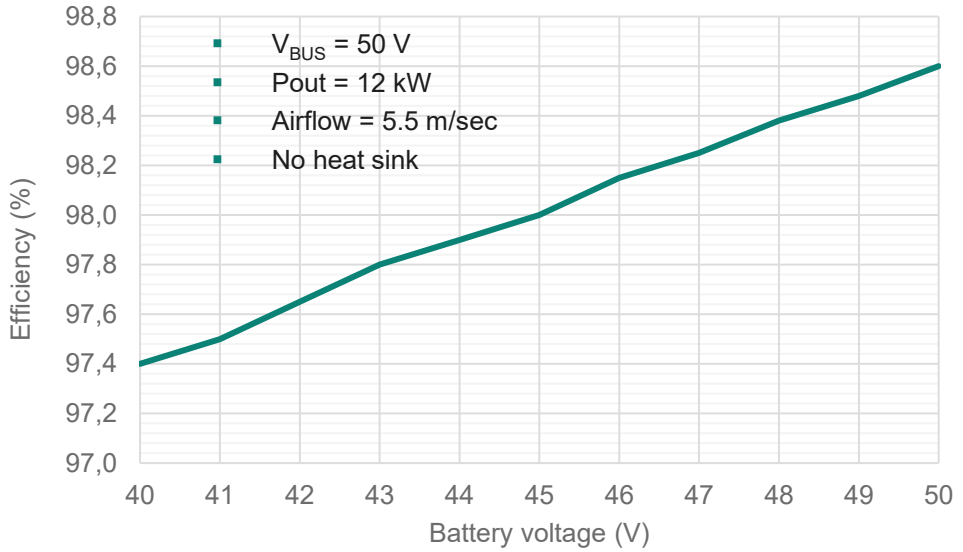
Key Features

- Bidirectional DCDC converter
- 4-phase design to deliver 12 kW Discharging; 1 kW Charging
- Power density per phase(without aux supply) ≈ 1315 W/in^3
- Topology Benefits - Reduced switch stress, lower inductance value

Buck mode



Boost mode



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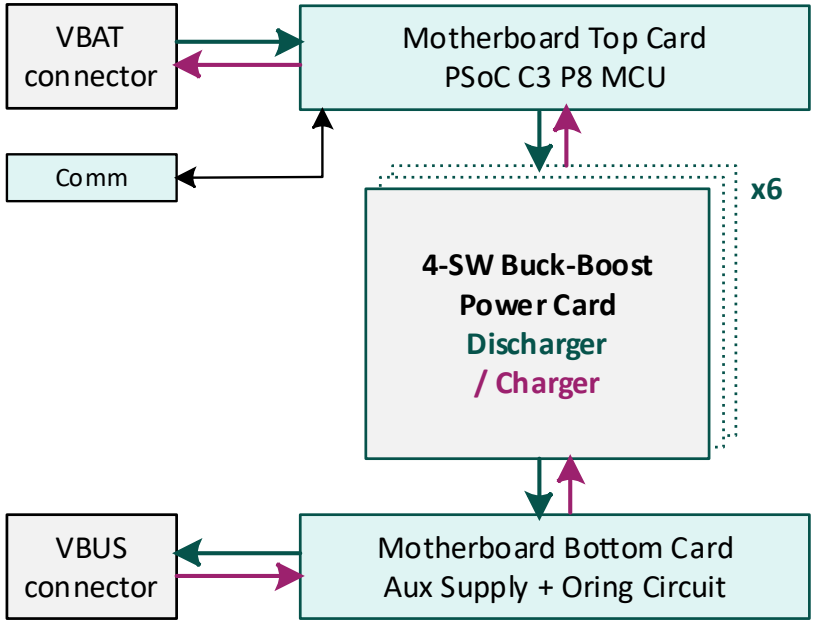
EVAL_48V_BBU_25KW powered by CoolGaN™

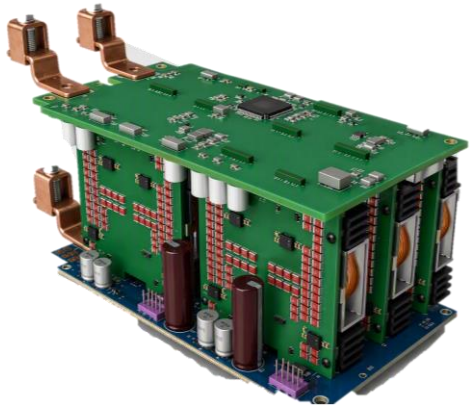
Power card (6x)
- 4.2 kW per card
- 2 buck-boost phases per card
- 4-SW buck boost topology
- Dimensions: 65x55 mm

Motherboard top card
- PSOC™ C3 P8 (3 core) MCU
- Main core: Secure bootloader
- Core 0: Digital Power Conversion
- Core 1: Communication interface
- Dimensions: 70x125 mm

Motherboard bottom card
- Auxiliary power supply
  - 12V FAN and 5V System supply
  - TDF10A01BG
- Oring circuits/Protection circuits
- Dimensions: 70x125 mm

Parameter	Value
Power	25 kW (6 power cards)
Vin (battery)	35 to 60 V (14S)
Vout (BUS)	50 V
Switching frequency	200 kHz
Peak efficiency	≥ 99.7%
Half load min efficiency	≥ 98.7%
Full load min efficiency	≥ 98%
Power density	≥ 1 kW/in^3
Size	75 x 75 x 125 mm
Mode	Buck / boost / pass-thru
GaN device	IGD01XK10S2
Controller	PSOC C3 P8 MCU

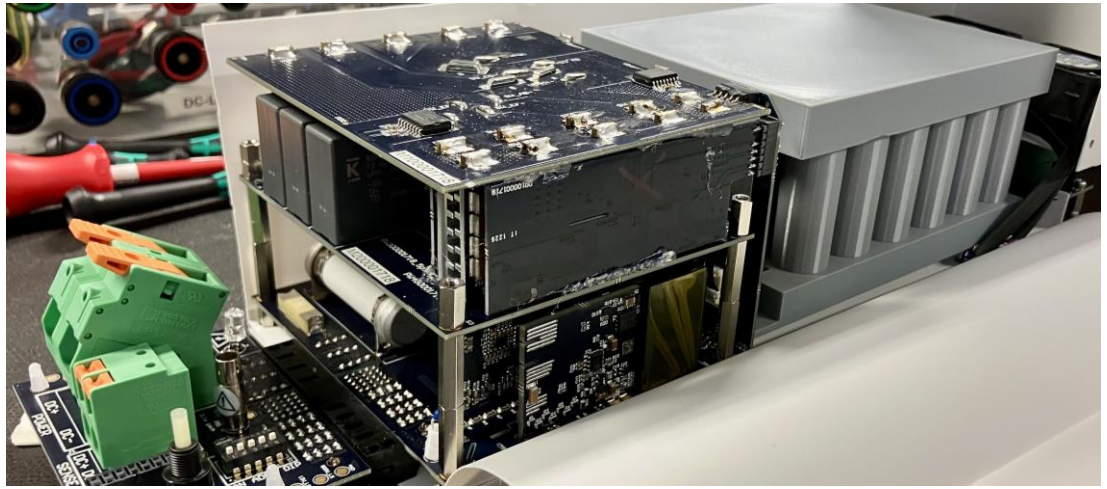




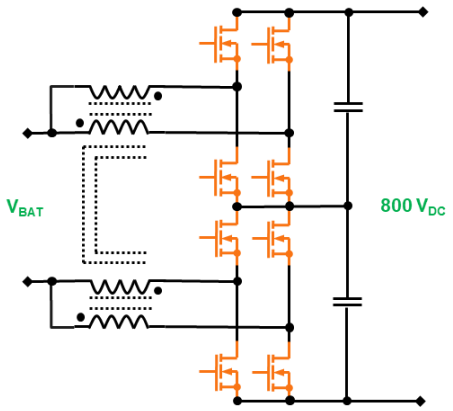
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Infineon as first mover shaping the transition to high voltage BBU by providing a 24 kW SiC BBU for 800 V DC distribution in rack

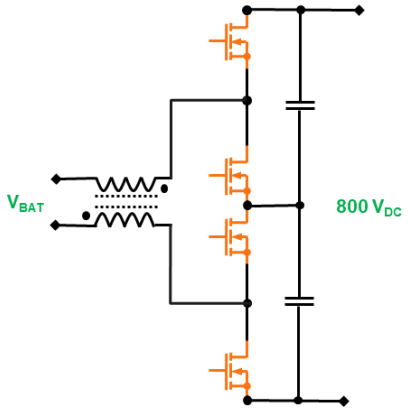
24 kW + 2.4 kW HV SiC solution for high voltage BBU



24 kW Multi-level Boost discharger converter



2.4 kW Multi-level Buck charger converter



Our **HV BBU solution is engineered** to deliver:

- **High power density (~350 W/in^3),** enabled by **magnetic integration**
- **High efficiency (>98%)**
- **Higher reliability** via multilevel topology w/o flying capacitors
- **Charger and discharger** blocks **share EMI filter**, **capacitors** and **protection MOSFETs**

With our **800 V design** we offer a complete **system solution**, integrating gate drivers, sensing, control and protecting:

- **800 V design with 650 V transistors**
- **CoolSiC™ MOSFET 650 V Generation 2 and SiC JFET 1200V**
- **EiceDRIVER™ Gate drivers**
- **TLE497x current sensors**
- **PSOC™ Performance line MCU**
- **CoolSET™ IC for auxiliary SMPS + 1.7 kV SiC MOSFET**

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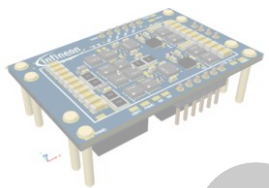
BBU / CBU system solution roadmap for 50V and HV racks

* Demo code available in ModusToolBox™

Learn more about our powering AI BBU system solutions

1.5 kW
Partial Power Converter

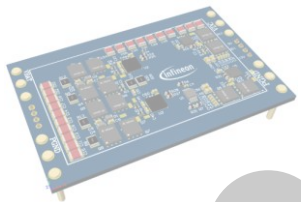
Si



Concept Board

4 kW
Partial Power Converter

Si



Concept Board

Tech demo

12 kW
Partial Power Converter
4 phase design
η > 99%

Si | PSOC C3P5

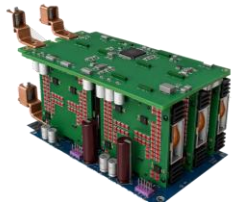


Available

Tech demo

25 kW
Buck Boost 6 phase design
η > 99%
~580 W/in³

GaN | PSOC C3P5



Q426

Ref. Board

24 kW
800 V HVDC BBU
3L Boost w/o flying cap
η > 98%
~340 W/in³

SiC | PSOC C3P8 *



Customer demo ready Nov 2026

Ref. Board

24 kW
Capacitor Bank Unit
For 800 V HVDC

SiC | GaN | PSOC C3P8 *



Q3/27

50 V DC BBU

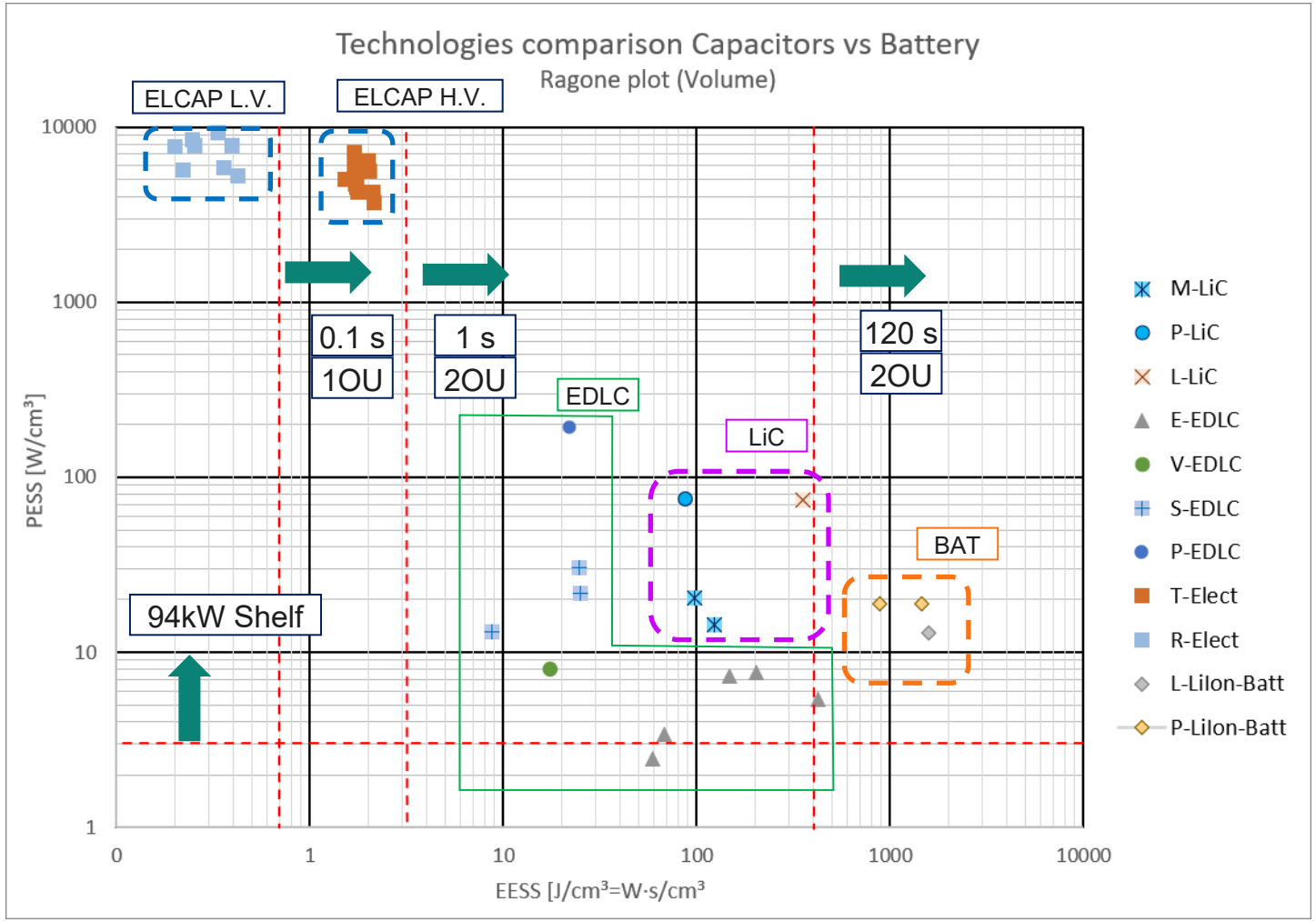
400 to 800 V DC BBU / CBU

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AI server rack and CBU trends



Choosing the best technology for peak power shaving and back up solutions



- Choose **EDLC** for **pulse buffering, peak shaving,very high cycle life and filtering ≤ 1 Hz (energy storage ≥ 1s)**
- Choose **LiC for more energy and longer backup** time than EDLC with still-good power delivery.
- Choose **Aluminum Electrolytic** for **higher-voltage bulk energy hold-up and filtering ≥ 10 Hz (energy storage ≤ 100ms)** at low cost.
- Choose **Li Ion batteries for back up power** solutions ranging **up to 4 minutes**

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Capacitor Bank Unit (CBU) Outlook – working on complementary solution for peak shaving

Capacitor Bank Unit 3D visualization



Q3/27

- Multi-phase multi-level approach.
- WBG based solution
- Targeting LiC / EDLC bank in order to cover the frequency domain between 0.1 and 1 Hz in the AC grid.
- Targeting 800 V DC bus
- Expand power capabilities by liquid cooling as a trend

Capacitor bank unit is a powerful **peak shaving solution**

Battery Backup Unit (Inside datacenter. Today white space, tomorrow in grey space)	**Capacitor Bank Unit** (Inside datacenter: in white and grey space)
Back-up time range: 90 ~ 240s e.g. LFP 18650 / 21700 type	Peak power shaving range: 100ms ~ 10s Li-Ion / EDLC / Alum Elec.

In future AI Data centers, **BBUs** and **CBUs** will **complement** each other. Additionally, they will be field interchangeable.

	White space	Grey space
Primary Function	Peak shaving covering EDPP of the GPU	Will support SST/TRU with HVDC fluctuations
Power Profile Handling	20 kW per module. From 80 to 100 kW per shelf	> 1 MW racks

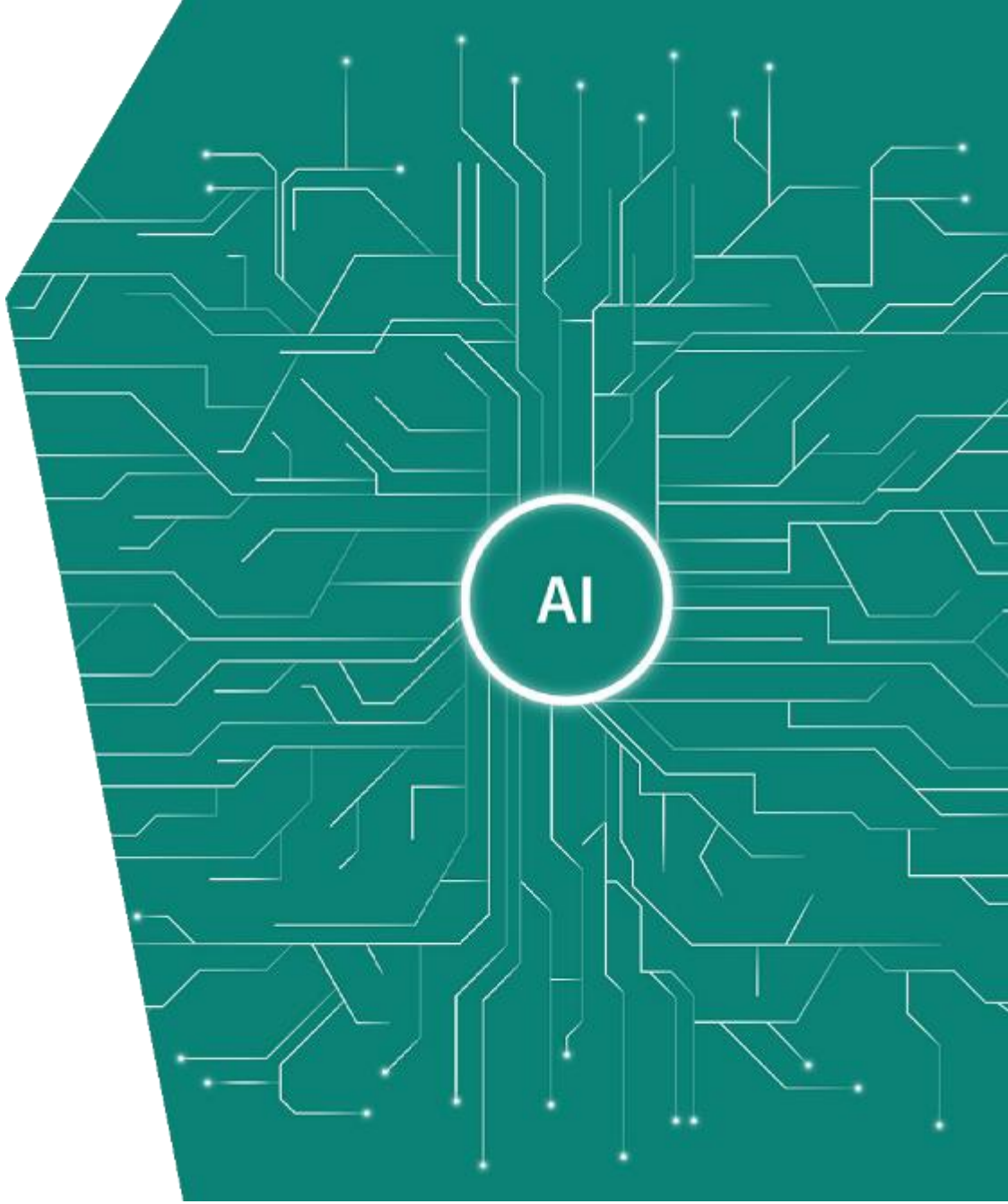
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Summary and resources



Summary and key take-aways

- AI servers show significant higher power trend and new rack architectures
- Racks higher power will push the BBU to higher voltage with HVDC output
- Specific CBUs are needed to meet the new requirements of peak shaving
- CoolSiC™ and CoolGaN™ technologies and portfolios are enabling the higher power and density BBUs
- A portfolio of system application boards are available/ in development to meet application requirements and accelerate customers' designs



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Application and product support materials

- BBU solutions
- AI BBU board roadmap
- Data center power solutions
- CoolMOS™
- CoolSiC™
- CoolGaN™
- OptiMOS™
- Gate Drivers™
- CoolSET™
- Current sensors
- Microcontroller

- AI and Data Center selection guide
- Whitepaper: the future of powering AI
- Whitepaper: High-efficiency BBUs with Infineon’s innovative DP-CF-SUSD topology

- Podcast series: We Power AI

- Developer community

- Optimizing AI Power Supply Units
- Power Supply ICs for efficient computing and networking
- Powering the heart of AI: 48 V to core optimization
- Hot-swap and eFuse strategies for modern data centers
- Introduction to Power System Reliability modeling



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