Increasing power density with small molded modules in medium power applications

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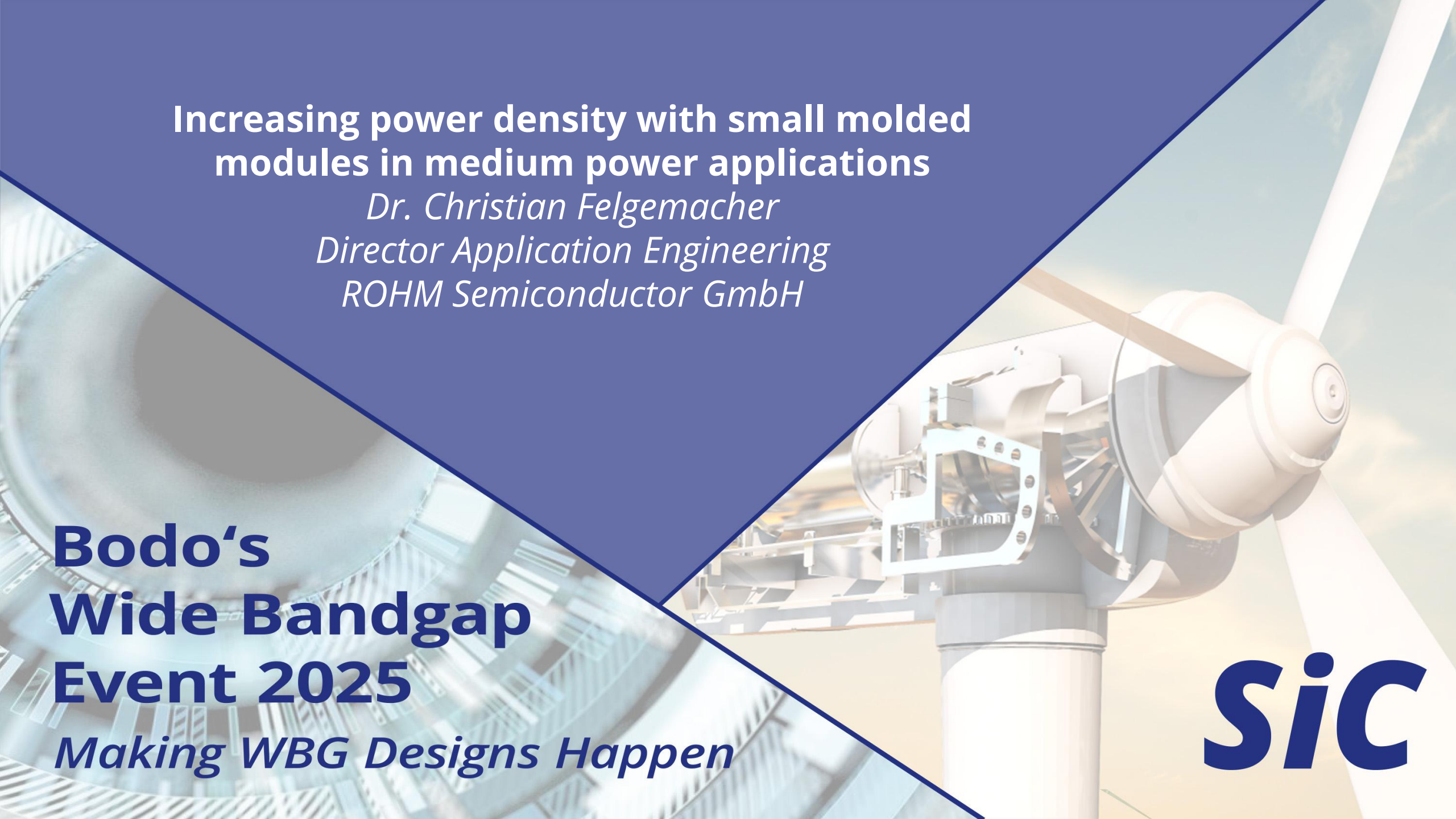


Bodo's Wide Bandgap Event 2025

Making WBG Designs Happen

SiC

Agenda

1. **Introduction – Gen 4 SiC MOSFETs / Package vs. Power Range**
2. Features and application benefits of DOT package
3. Target applications
4. Conclusions

4th Generation SiC MOSFETs

Efficient

Reduced $R_{DS(on)}$·A allows for:

Smaller chips
- Similar $R_{DS(on)}$ @ 25°C
- Lower switching loss

Same size chip:
- Lower $R_{DS(on)}$ @ 25°C

Select suitable chip selection for application needs

Versatile

Less than 10% conduction loss change between $V_{GS(ON)}$ = +15 / +18 V

+15V / +18V

Support for $V_{G(off)}$ = 0V

Because of high V_{th} / favourable C_{GS}/C_{GD} risk of PTO is low even for $V_{G(off)}$ = 0V

- **No negative rail needed in GD unit**
- **Reduced BOM cost**

Reliable

SC

Short circuit withstand capability ensured even with reduced $R_{DS(on)}$·A

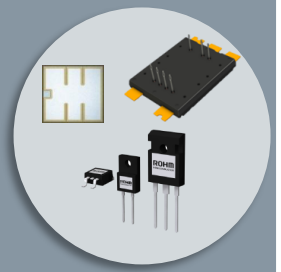
Extensive testing coverage with successful qualifications for xEV powertrain

Wide Portfolio

750 V / 1200 V

Technology for three voltage classes: 750V, 1200V, 2000V

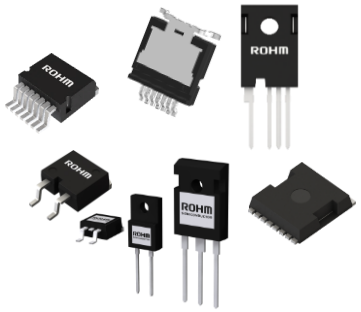
Wide offer of devices from bare die to many discrete packages and modules.



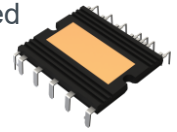
Wide choice of performant and reliable devices available for many applications !

SiC Power Packages (750 / 1200V)

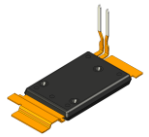
Our new 2-in-1 DOT-247 module fits the power range between discretes and larger modules.



4/6-in-1 Molded Modules
HSDIP20

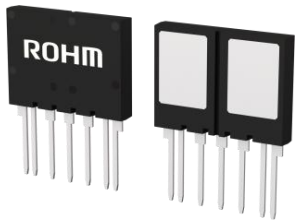


~ 30 .. 90 A



Single Switch Module
BSTB
Under development

~ 130 .. 250 A



New
2-in-1 Molded Modules
DOT-247**
From 2025

~ 100 .. 250 A

2-in-1 Molded Modules
TRCDRIVE pack™
Since 2024

> 400 A

2-in1- case type
E type / G type
Since 2012

~ 200 .. 600 A

50 A | 100 A | 200 A | 300 A | 400 A | 500 A | 600 A

Rated Current

OBC/DCDC

DC charger

Server PSU

xEV
traction inverter

PV (central)
/ power conversion

**The official package name of the product is DOT-247-7L

*TRCDRIVE pack™ is a trademark or registered trademark of ROHM Co., Ltd.

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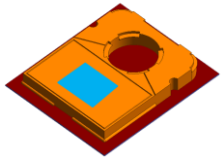
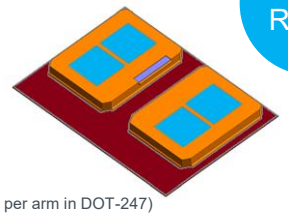
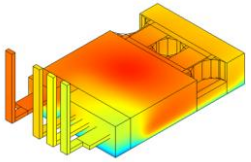
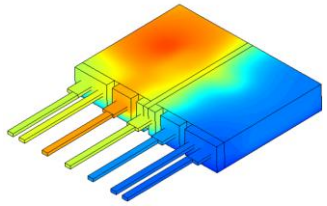
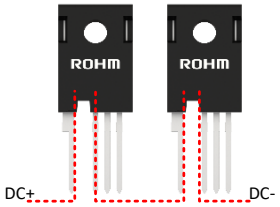
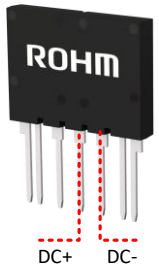
Key benefit of DOT-247: Higher power density

Package level features supporting increased power density

	TO-247	New DOT-247
Optimised lead-frame mounting area	Available space limits the chip area Best possible $R_{DS(on)}$ for a 1200V device appox. **13 mΩ**	Frame without mounting hole → more mounting area & paralleling is possible Best possible $R_{DS(on)}$ for a 1200V device appox. **6 mΩ**
		 (Assuming 2chips per arm in DOT-247)
Simple cooling path comparable to TO-247		 (Simulation with only one arm energized)
Stray inductance reduced by internalising the half-bridge structure to the package. Conditions: Tvj=25 ℃, Terminal P to Terminal N (DOT-247)	 TO-247 is assumed to be used as a half-bridge (2 pcs)	Reduced Approx. 48% 

Low $R_{DS(ON)}$

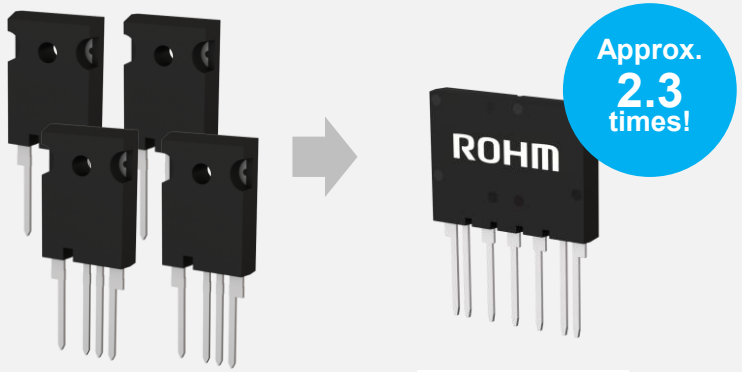
Good heat dissipation

Low inductance

Significant power density improvement

TO-247

New DOT-247



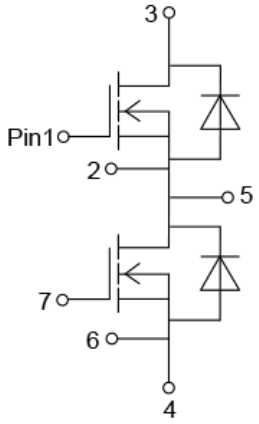
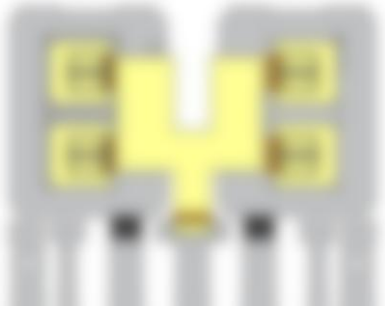
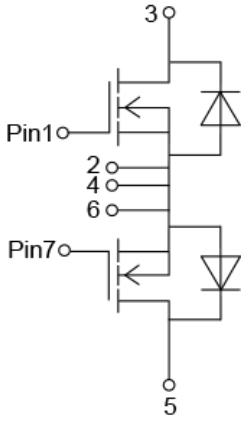
TO-247 × 4pcs

2-in-1×1pcs

In a half-bridge circuit, DOT-247 delivers the same power using only half the molding volume!

Additional benefit: DOT-247 supports two topologies

With same lead frame two topologies can be realised

	DOT-247 *New*
Half-Bridge	 
Common-Source	 

DOT-247 can support a wide variety of topologies!

Cu-Clip technology to support high power cycling requirements

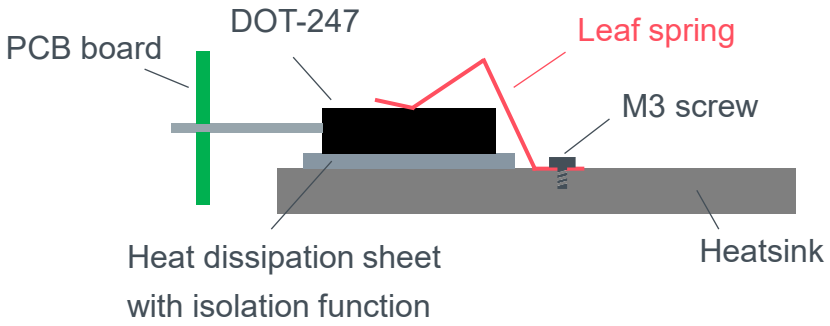
Note: Layouts shown for illustration only. Actual products may have different layouts

Mounting method: Off the shelf leaf spring

Evaluations show that mounting with a standard leaf spring results in good thermal performance

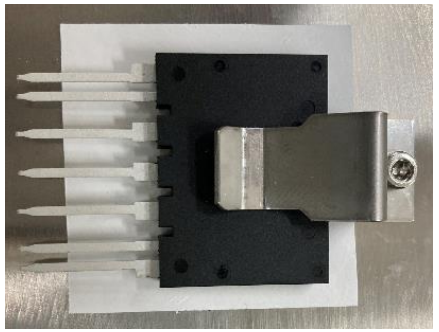
Assembly method with leaf spring

・Side view

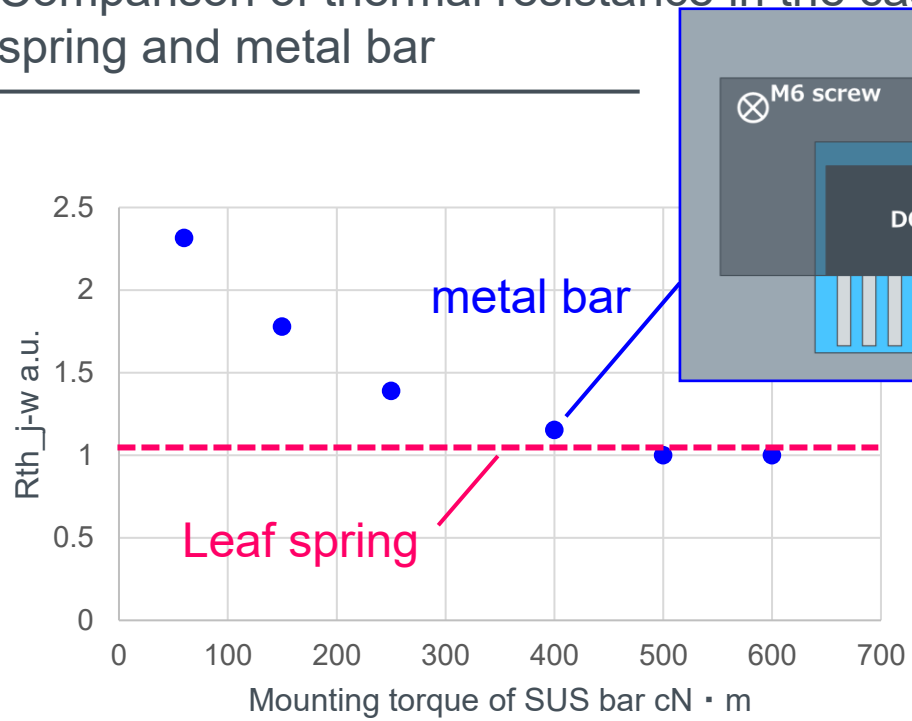


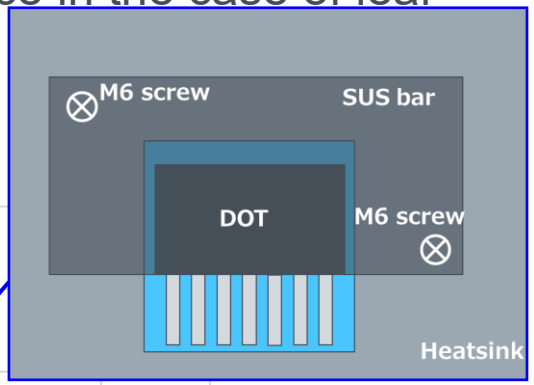
・Top view

Center of the package is clamped with 1 leaf spring.



Comparison of thermal resistance in the case of leaf spring and metal bar



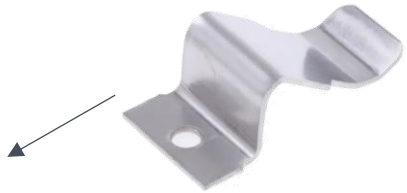


・Measurement setup condition

Leaf spring：Fischer Elektronik THFM1

Mounting torque of leaf spring：M3, 60cN・m

Heat dissipation sheet：Denka BFG20A (5 W/mK, 0.2 mm)



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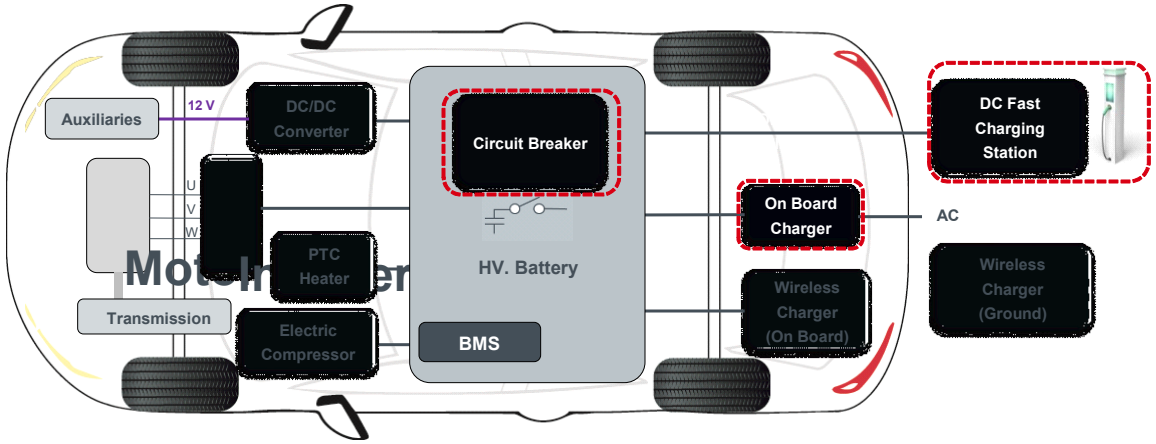
3. **Target applications**
4. Conclusions

DOT-247 target applications

Automotive xEV applications



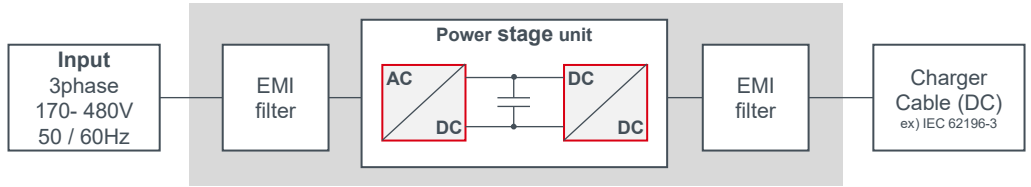
- Battery switch in xEV
- On Board Charger (OBC)
- DC Fast Charging Station

Industrial applications

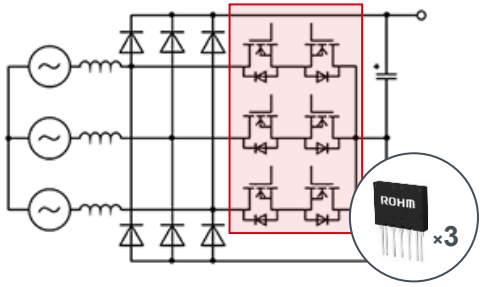
- UPS / ESS
- PV Inverter
- FA
- EV Charger Station
- Server/Telecom PSU
- SSCB

EV Charging Station / Fuel Cell Vehicle (FCV)

EV Charging Station



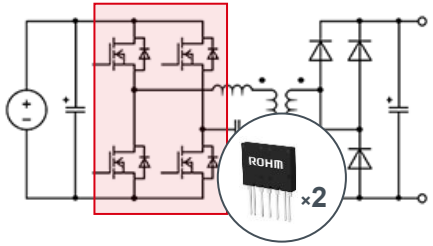
AC-DC



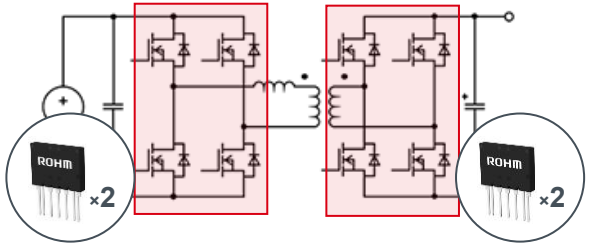
3-phase 3-level PFC

- DOT 247 modules support topologies common to power modules in DC chargers
- Simpler design than using many discretes, more cost effective than some module solutions.

DC-DC



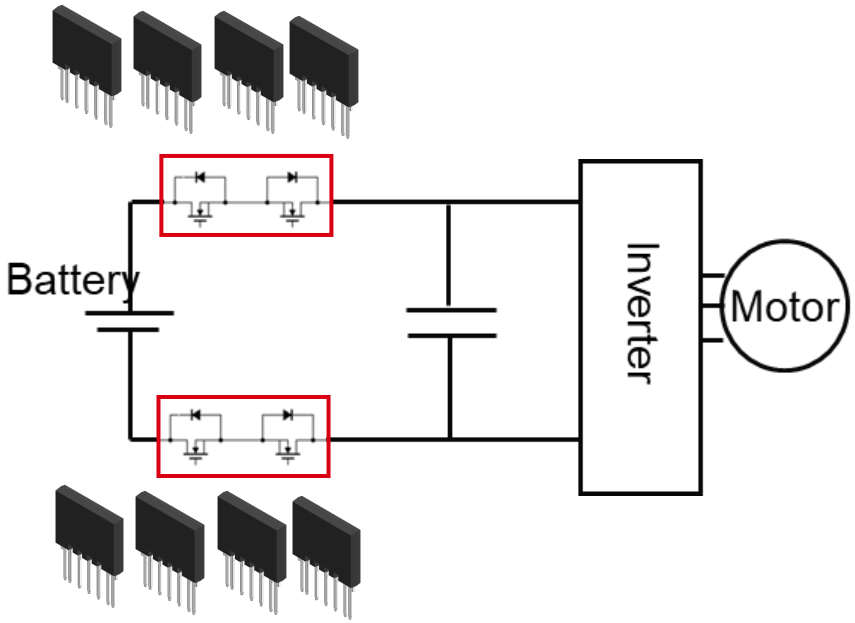
LLC Converter



Dual Active Bridge (DAB) Converter

Battery Switch / SSCB

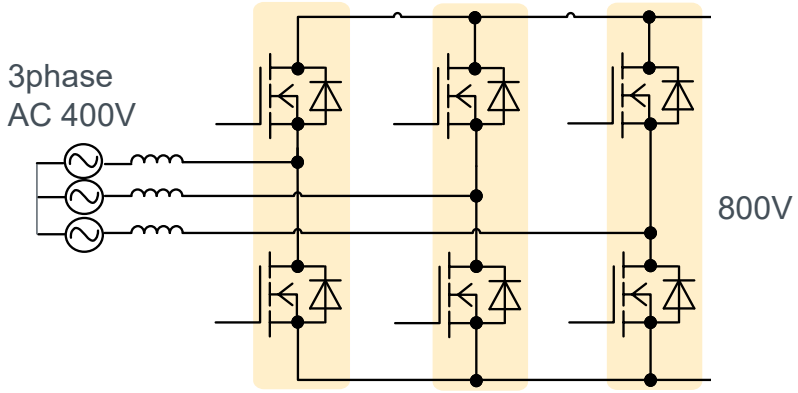
Common source type is applicable as battery switch in xEV and a possible building block for solid state circuit breaker



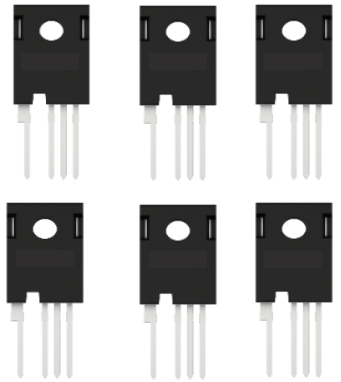
Example: 750V 6.5 mohm 4pcs in parallel for 300 .. 350 A battery relay

3phase Full Bridge PFC for OBC or other AC/DC systems

Example：11kW-3 phase Full Bridge PFC V_{output} = 800V

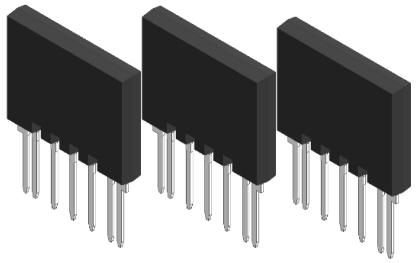


TO-2471200V 20mΩ x 6pcs



Power density improvement

DOT-247 1200V 18mohm x 3pcs

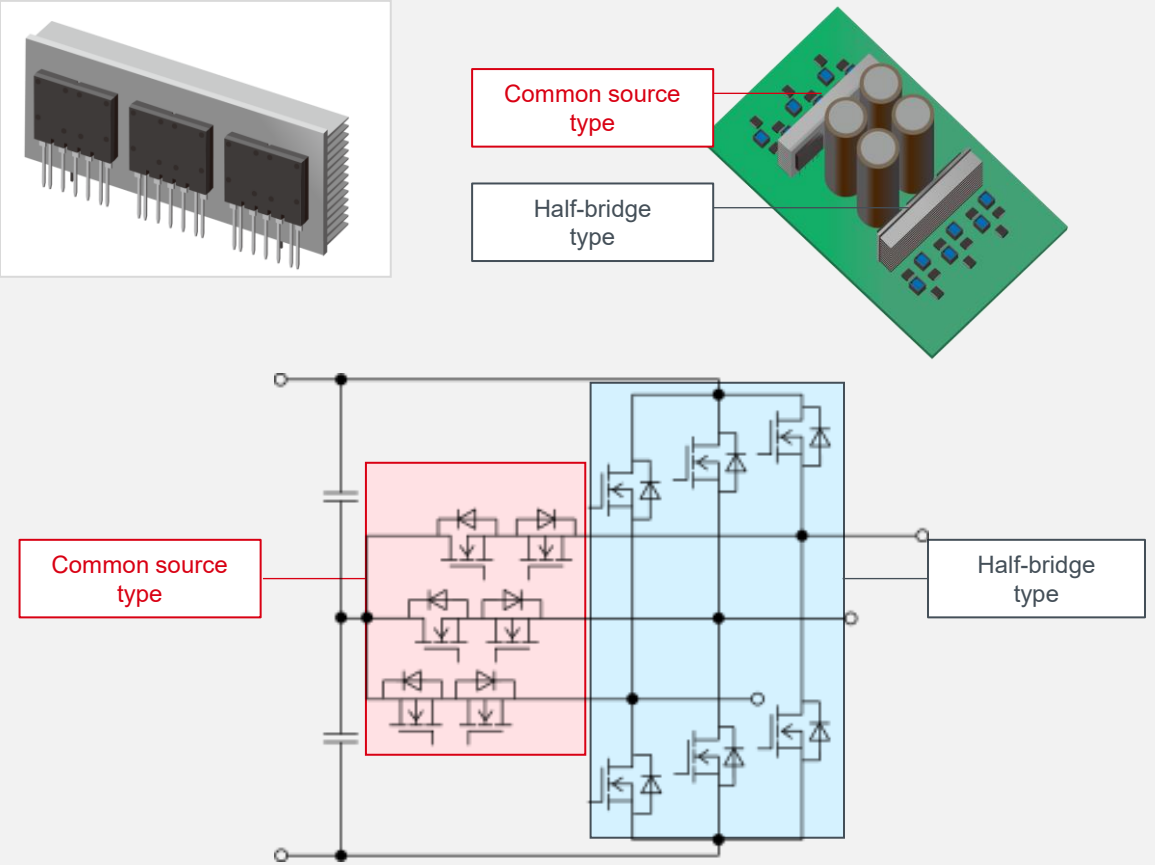


	P_{out}	Id (each phase)	recommend	3 phase Full bridge PFC BOM
11 kW / 800V	11 kW	Id=~54A	(TO-2471200V 20mΩ x 1para)x2pcs/each phase	**6**pcs
			DOT-247 1200V 18mΩ/each phase	**3**pcs
	22 kW	Id=~108A	(TO-2471200V 19mΩ x 2para)x2pcs/each phase	**12**pcs
			DOT-247 1200V 9mΩ/each phase	**3**pcs

Example for replacement From TO-247 to DOT-247

1200V 9 / 18mohm DOT-247 is better choice for >= 11kW 3phase Full Bridge PFC

DOT-247: Ideally suited to realise T-Type NPC



- Easy T-type NPC configuration thanks to the common-source topology.
- Mid-power converters can be realized thanks to lower R_{DS} and $R_{th,j-c}$.

Application using T-type NPC Topology



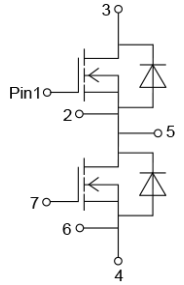
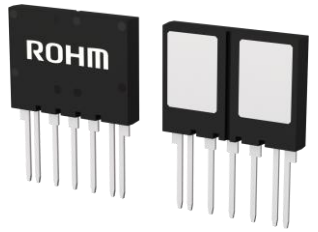
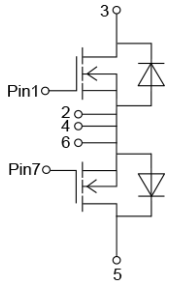


- UPS / ESS
- PV Inverter
- FA
- EV Charger Station
- Server / Telecom PSU

Benefits of DOT-247

- Building blocks readily available
- Low $R_{DS(on)}$ components enable design without paralleling
- Expecting significant volume savings over traditional discrete solution

Product Lineup and Development Schedule
(4th Gen SiC MOSFET)

Part No.	Absolute Maximum Ratings (Tj= 25°C)			Circuit Diagram	Package [mm]	AEC-Q101 Qualified**	SPICE Model
	V_{DSS} [V]	$R_{DS(on)}$ [mΩ]	I_D [A]				
☆ SCZ4018KTAHR	1200	18	76	 Half bridge	 DOT-247-7L 31.5×41.0×5.0	YES	After 2025/10
☆ SCZ4009KTAHR		9	149			YES	After 2025/10
New SCZ4011KTA		11	106			—	YES
New SCZ4006KTA		6	209			—	YES
☆ SCZ4013DTAHR	750	13	96			YES	After 2025/10
☆ SCZ4007DTAHR		6.5	187			YES	After 2025/10
New SCZ4008DTA		8	134			—	YES
New SCZ4004DTA		4	251			—	YES
☆ SCZ4018KTBHR	1200	18	76	 Common source		YES	After 2025/10
☆ SCZ4009KTBHR		9	149			YES	After 2025/10
New SCZ4011KTB		11	106			—	YES
New SCZ4006KTB		6	209			—	YES
☆ SCZ4013DTBHR	750	13	96			YES	After 2025/10
☆ SCZ4007DTBHR		6.5	187			YES	After 2025/10
New SCZ4008DTB		8	134			—	YES
New SCZ4004DTB		4	251			—	YES

☆Under development

**AEC stands for Automotive Electronics Council, a reliability standard for automotive electronic components established by major automotive manufacturers and US electronic component makers. AEC-Q101 is a standard that specifically applies to discrete semiconductor products (i.e. transistors, diodes).

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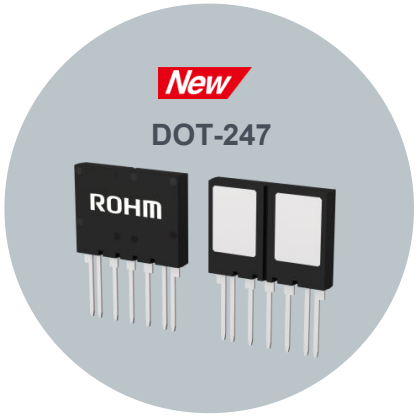
Conclusions

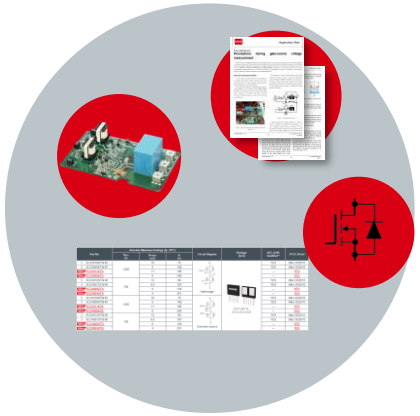
EcoSiC

- Established portfolio of 4th Generation SiC MOSFETs
- Devic technology for 750V, 1200V and 2000V
- Portfolio of bare die products, various discrete packages and modules.

New package: DOT-247-7L

- Closes the gap between high power modules and discrete devices.
- Flexible to use in both half-bridge and common-source topology.
- Can drive improvements in power density for various applications.





Ready to support you

- First devices are available including simulation models (PLECS, SPICE).
- Supporting material expanding continuously for various products and applications.
- HW support tools for DOT in preparation (EVKs for DPT / 3~ inverter)
- Our teams are looking forward to supporting your projects

Thank you for your attention!

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