CoolSiC™ MOSFET 750 V G2

empowering the next generation of high-performance power conversion system

german brand award '24 corporate brand of the year

Table of contents

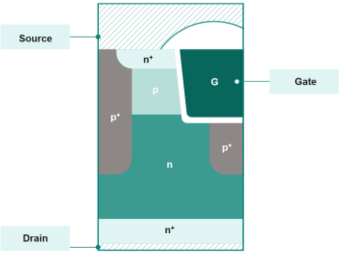
Table of contents

SiC is at the strategic core to adress key market trends for sustainable energy generation and consumption

Silicon Carbide must haves – getting ready today to continue shaping the market tomorrow

1. Trench technology

- Committed to offering optimal balance between performance and robustness
- Keeping up with state-of-the-art IGBT robustness, while boosting efficiency performance to new levels.



2. Synergies between chip and package

- Committed to offer highest degree of innovation by leveraging strong expertise in interconnect technologies
- Sophisticated soldering processes for maximum chip performance

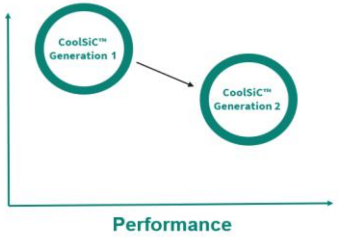
SiC + .XT

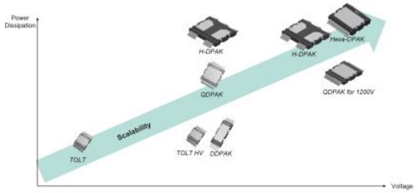
3. Manufacturing know-how and supply security

- Committed to support steep volume growth of our customers
- multi-source raw material base and FE capacity expansion and inhouse BE lines

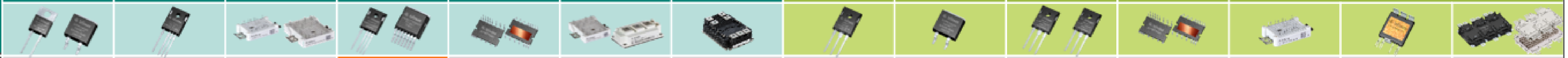
4. Innovation in technology and packages

- Our relentless pursuit of innovation in technology and packages to provide the cutting-edge devices





Our extensive CoolSiC™ Portfolio Covers Everything You Need



package options / voltages	Industrial grade: CoolSiC™ Diode – Discrete	Industrial grade: CoolSiC™ Hybrid – Discrete	Industrial grade: CoolSiC™ Hybrid – Module	Industrial grade: CoolSiC™ MOSFET – Discrete	Industrial grade: CoolSiC™ MOSFET – IPM	Industrial grade: CoolSiC™ MOSFET – Module	Industrial grade: CoolSiC™ MOSFET – HP module	Automotive grade: CoolSiC™ Diode – Discrete	Automotive grade: CoolSiC™ Hybrid – Discrete	Automotive grade: CoolSiC™ MOSFET – Discrete	Automotive grade: CoolSiC™ MOSFET – IPM	Automotive grade: CoolSiC™ MOSFET – Module	Automotive grade: CoolSiC™ MOSFET – Module	Automotive grade: CoolSiC™ MOSFET – Module
400 V				G2 mass production										
440 V				G2 mass production										
600 V	mass production													
650 V	mass production	mass production	mass production	mass production / G2 mass production				G1 mass production	G1 mass production				G2 in development	
750 V				mass production / G2 mass production	G2 in development					G1 mass production / G2 mass production	G2 in development			G2 mass production
950 V			mass production											
1200 V	mass production		mass production	mass production / G2 mass production	mass production / G2 in development	mass production / G2 in development				G1 mass production	G2 in development	G1 mass production	G2 in development	G1 mass production / G2 mass production
1400 V				G2 in development										
1700 V				mass production										
2000 V	mass production			mass production		mass production								
3300 V							mass production							

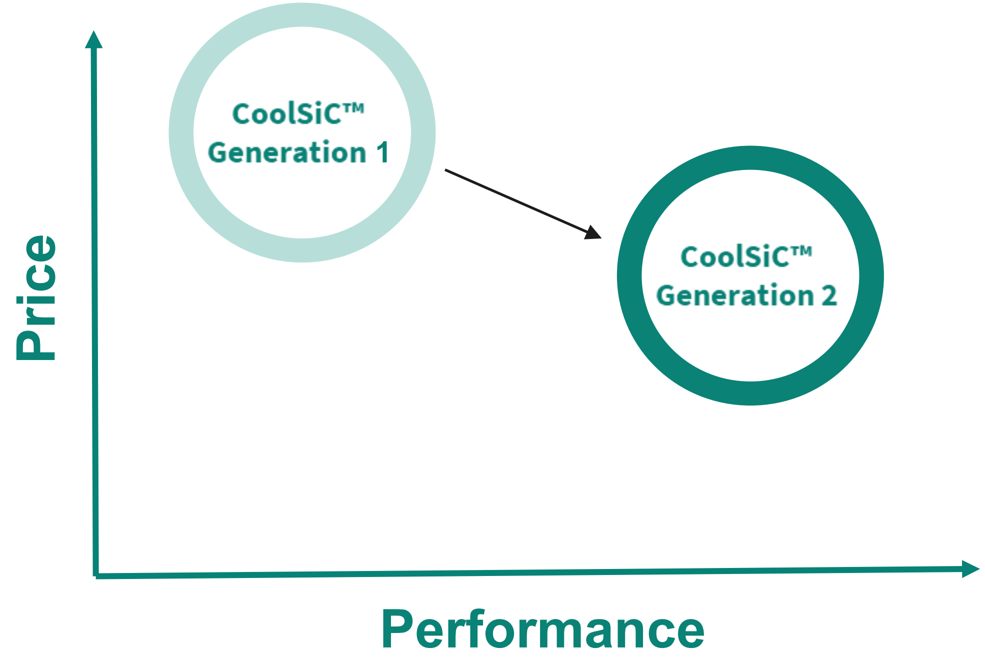
Continuous extension of portfolio

Legend (Industrial grade): mass production; G2 mass production; G1 in development; G2 in development

Legend (Automotive grade): G1 mass production; G2 mass production; G2 in development

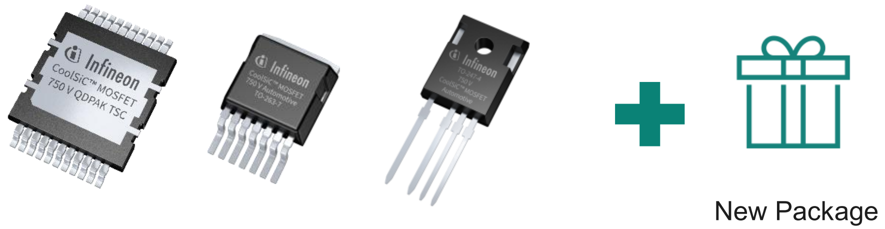
Note: Numerous CoolSiC™ devices feature .XT interconnection technology. For details refer to the .XT landing page

CoolSiC™ MOSFET 750 V G2 Automotive and Industrial:
higher system performance per $ or € invested in SiC



Advantages

Generation 2 enables the design of more cost optimized, efficient, compact, and reliable systems.



8 mΩ - 140 mΩ	750 V G1	SoP 2023
4 mΩ - 60 mΩ	750 V G2	>SoP E.2025

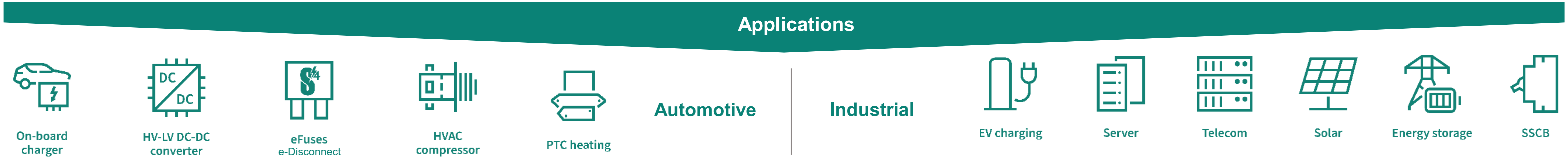


Table of contents

CoolSiC™ 750 V G2 builds on the outstanding performance of G1

Additional features and improvements

750 V CoolSiC™ G2

Improved efficiency by reduced switching loss	better	**FoM 30~40% at HOT** Improvement vs G1
Unipolar driving with best immunity against parasitic turn-on **Bipolar driving with enlarged Vgs** for best compatibility	better	$V_{GS(on)}$/ $V_{GS(off)}$:18V/0V to reduce driving scheme cost and complexity $V_{GS(static)}$ -7 ~23V for best compatibility
Overload operation up to T_{vj} = 200°C	new	**Unique robustness** against surge current event
Short circuit withstand up to 2 µs	new	**Increased robustness** for extreme short circuit condition
Maximum $R_{DS(on)}$ at Tj = 150°C specified in datasheet	new	Reduce **margin over-stacking** for a cost/performance efficient design
A more granular portfolio with Best-in-class $R_{DS(on)}$	more	**BiC 4mΩ in Q-DPAK**
New TSC package to increase the power density and integration to next level	more	**H-DPAK Half-bridge** same height 2.3mm as Q-DPAK

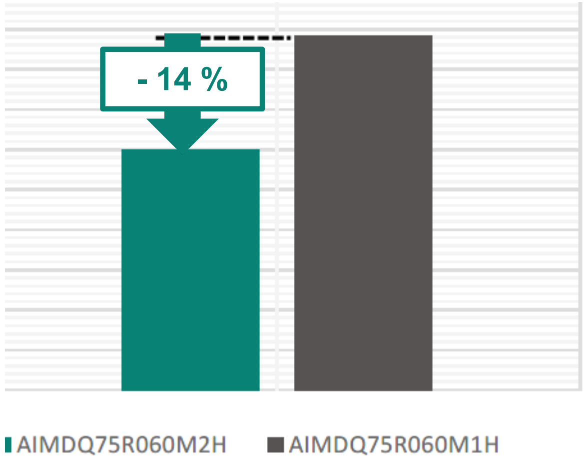
Same features as 750V G1 following its success story:

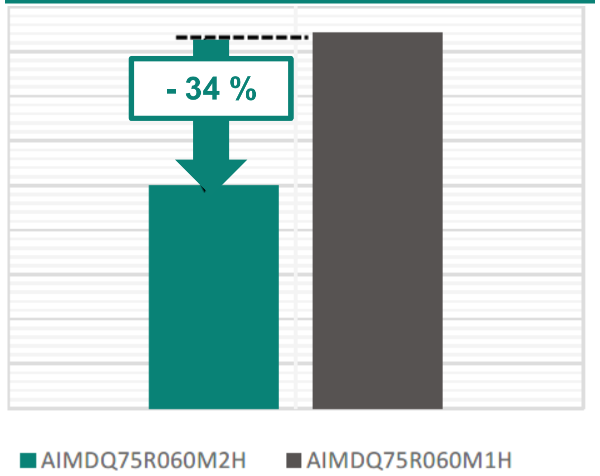
- Highly robust 750 V for V_{bus}>500 V, 100% avalanche test in production
- Best immunity to parasitic turn-on, Unipolar driving
- Best-in-class Gate Oxide robustness
- Robust .XT interconnect technology
- AECQ-101 with outstanding reliability for automotive products

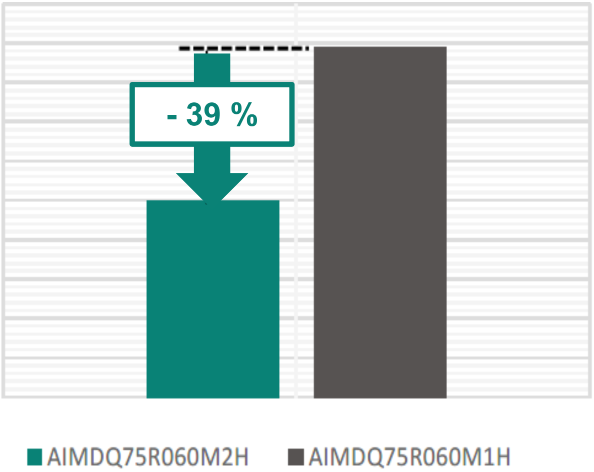
Unveiling a new performance with CoolSiC™ G2
FoM at 125°C

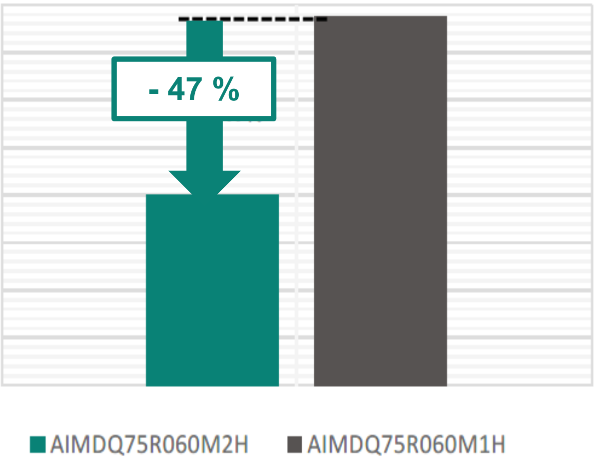
Figures-of-merit (FOM) comparison: lower is better for energy efficiency optimization

The classical MOSFET FOM (from low-voltage silicon world)			
$R_{DSON,typ}$ x Q_G (mΩ*nC) at 125°C	$R_{DSON,typ}$ x Q_{OSS} (mΩ*nC) at 125°C	$R_{DSON,typ}$ x E_{OSS}(mΩ*µJ) at 125°C	$R_{DSON,typ}$ x Q_{fr} (mΩ*nC) at 125°C
Lower means lower gate driving power loss	Lower is better in soft-switching topologies	Lower is better for light-load efficiency	lower is better for hard-switching half-bridge top.







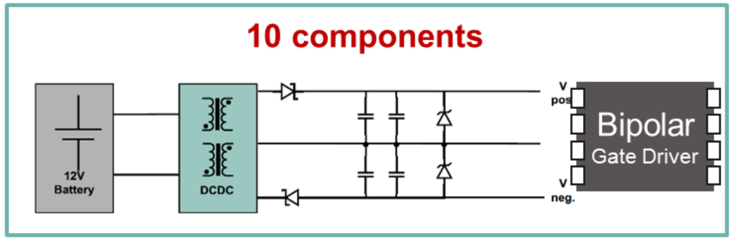


Infineon products: AIMDQ75R060M1H, AIMDQ75R060M2H
Q_G = total charge at given conditions, Q_{oss}= total charge associated to C_{OSS} at given conditions. E_{OSS} = total energy associated to C_{OSS} at given conditions
Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

CoolSiC™ Gen2 offers high immunity against parasitic Turn-ON and best compatibility in gate driving range

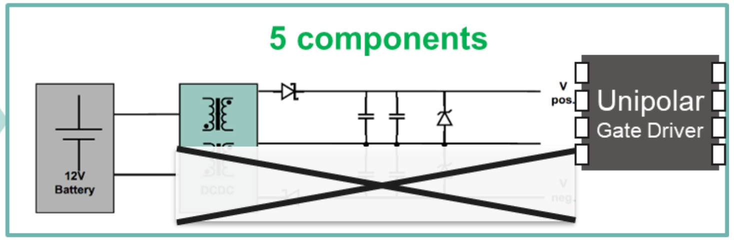
Unipolar driving enabled by higher Vgs(th) and robustness against parastic turn-ons

Negative gate voltage turn-off



- ✓ - 50% BOM & Space
- ✓ Less complex transformer

0V gate voltage turn-off



- Less BoM cost
- Less complexity

Bipolar driving with higher flexiblity on driving voltage / margins and best compatibility

Gen1

Gate source voltage (static)	V_{GS}	-5	-	23	V	-
Gate source voltage (transient)	V_{GS}	-10	-	25	V	$t_p \leq 500$ ns, duty cycle ≤ 1%

* Source: AIMDQ75R016M1H Final Datasheet

Gen2

Parameter	Symbol	Values			Unit	Note / Test condition
		Min.	Typ.	Max.		
Gate source voltage (static) 3)	V_{GS}	-7	-	23	V	-
Gate source voltage (transient)	V_{GS}	-11	-	25	V	$t_p \leq 500$ ns, duty cycle ≤ 1%

* Source: AIMDQ75R016M2H Final Datasheet

- Higher flexibility
- Higher design margin
- Best 2nd source compatibility

Increased robustness feature with $T_{j\_max.}$ upto 200°C for overcurrent events

Gen 2 *

Public

CoolSiC™ Automotive Power Device 750 V G2

AIMDQ75R016M2H

1 Maximum ratings

at T_j = 25°C, unless otherwise specified.

Table 2 Maximum ratings

Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_j	-55	-	175	°C	-
Extended operating junction temperature 4)	T_j	-	-	200	°C	≤ 100 h in the application lifetime

New

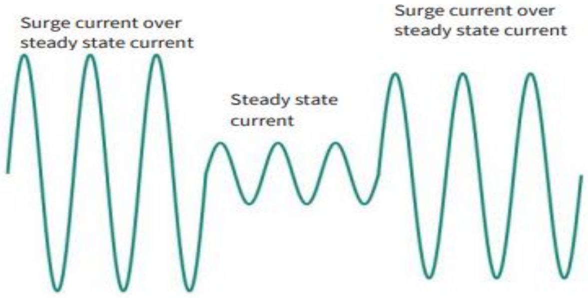
1) Limited by $T_{j,max}$.

2) Pulse width t_{pulse} limited by $T_{j,max}$.

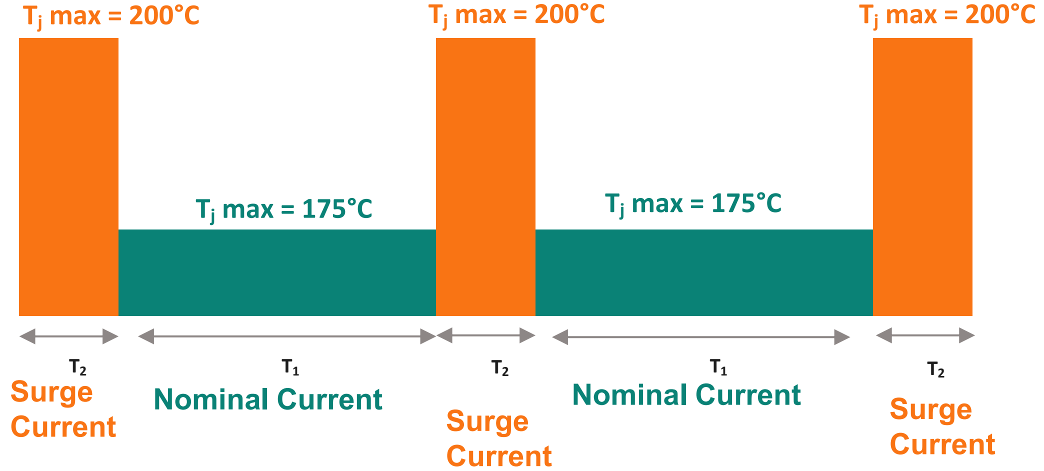
3) The maximum gate-source voltage in the application design should be in accordance to IPC-9592B.

4) Up to 7500 temperature cycles, where maximum delta T is limited to 100K.

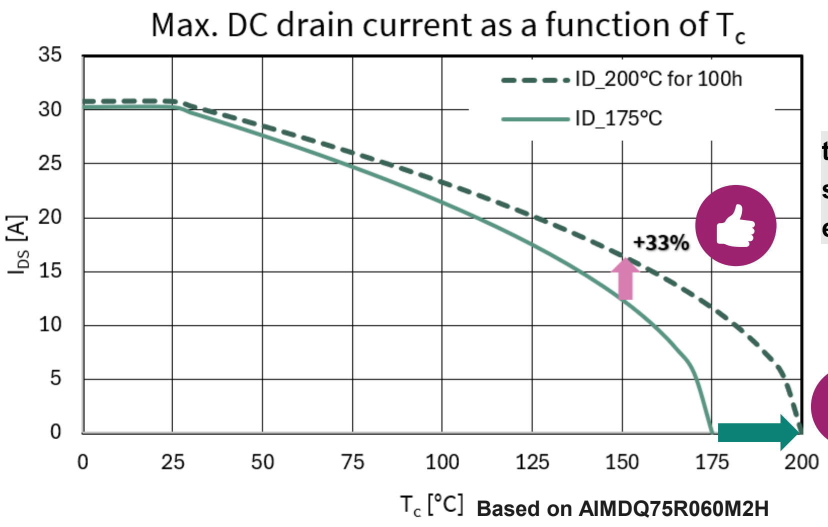
** Source: AIMDQ75R016M2H Final Datasheet*



Example of load current variation and Tj due to repetitive surge events



Extended power dissipation capability of CoolSiC™ 750 V Gen 2



Based on AIMDQ75R060M2H

the dashed curve of CoolSiC™ G2 shows that 33% more current is enabled at the same operating point

Tj max is extended to 200 °C under condition as specified in the datasheet

Source: Application Note- AN125027 _ CoolSiC™ 750 V G2 automotive MOSFET

Improved $R_{DS(ON)}$ max./typ ratio
Maximum $R_{DS(ON)}$ at T_j = 150°C and

Gen1

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source on-state resistance	$R_{DS(on)}$	-	20	-	mΩ	V_{GS} = 15 V, I_D = 41.5 A, T_j = 25 °C
		-	16	22		V_{GS} = 18 V, I_D = 41.5 A, T_j = 25 °C
		-	15	-		V_{GS} = 20 V, I_D = 41.5 A, T_j = 25 °C
		-	29	-		V_{GS} = 18 V, I_D = 41.5 A, T_j =175 °C

* Source: AIMDQ75R016M1H Final Datasheet

Gen2

Parameter	Symbol	Values			Unit	Note / Test condition
		Min.	Typ.	Max.		
Drain-source on-state resistance	$R_{DS(on)}$	-	21	-	mΩ	V_{GS} = 15 V, I_D = 55.8 A, T_j = 25°C
			16	20		V_{GS} = 18 V, I_D = 55.8 A, T_j = 25°C
			14	-		V_{GS} = 20 V, I_D = 55.8 A, T_j = 25°C
			25	32		V_{GS} = 18 V, I_D = 55.8 A, T_j = 150°C
			29	-		V_{GS} = 18 V, I_D = 55.8 A, T_j =175°C
Internal gate resistance	$R_{G,int}$	-	2.4	-	Ω	f = 1 MHz

* Source: AIMDQ75R016M2H Final Datasheet

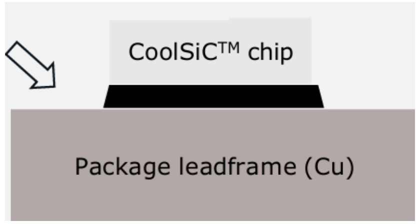
Reduced over-stacking design margin

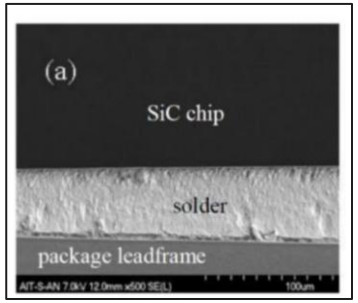
More cost/performance efficient design

CoolSiC™ MOSFETs 750 V
Significant improvement of thermal capabilities by .XT interconnection

SiC Synergies between the chip and its package

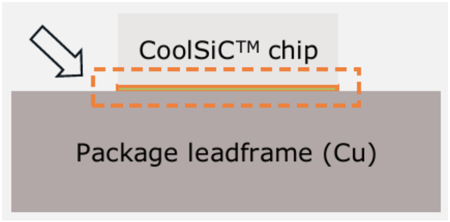
Standard interconnection

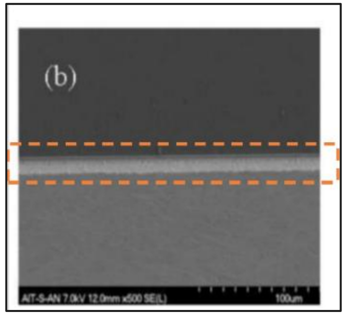




Standard soldering

.XT interconnection

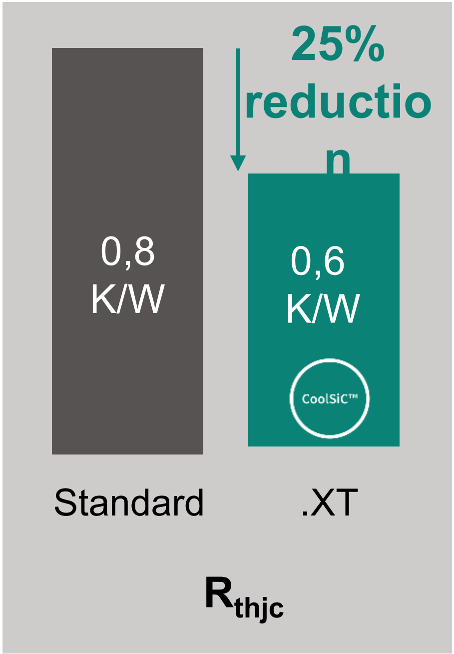




Elimination of solder joint through **diffusion soldering**

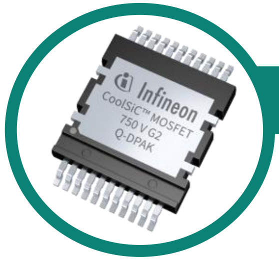
.XT technology benefits

Improved thermal conductivity & reliability performance*

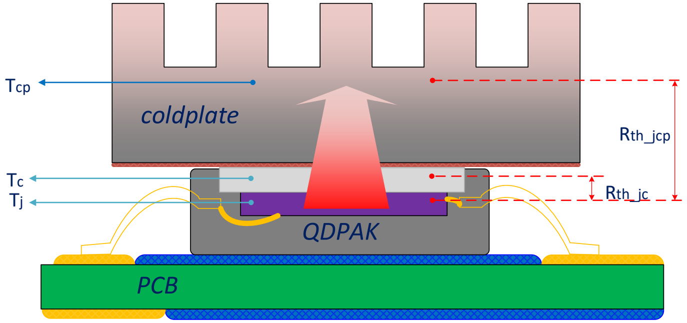


*at same form factor

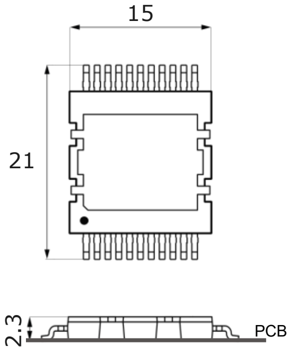
Top-side-cooling enables optimal mechanical cooling design, reduces manufacturing and BOM cost significantly



Q-DPAK TSC

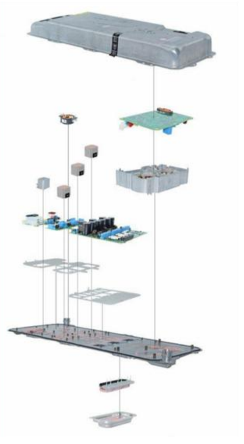


JEDEC registered



Note: All dimension in millimeters

Simplified assembly



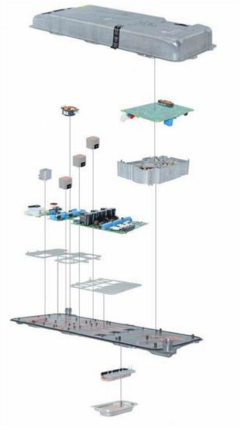
41 -76%
Nr. of connectors

PCB: FR4

No stacking of different boards needed

One big FR4 PCB:
all power components
and IC/driver/magnetics

€

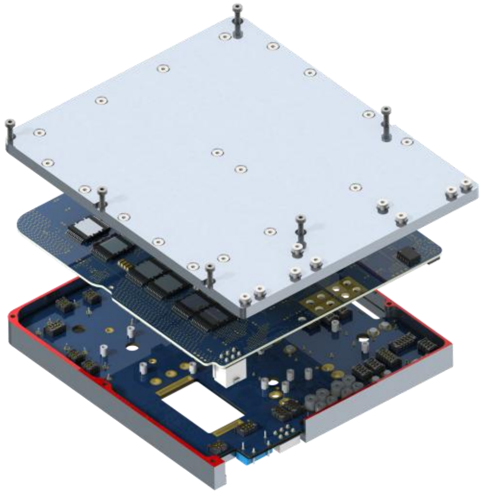


-33%
Assembly costs

-18%
FR4 PCB cost

-76%
Nr. of connectors

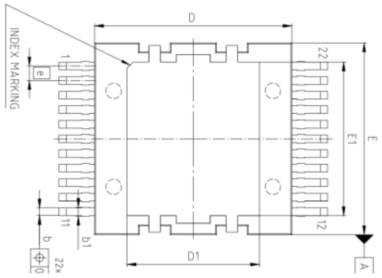
**Based on A2mac teardown reports*
C Segment passenger car, Production year 2020, 11kW OBC



- **Thermal & electrical performance**
- **Increased power density**
- **PCB layout flexibility**
- **Manufacturing advantage**
- **Stability and system lifetime**

HV Q-DPAK is fulfilling creepage norm DIN EN 60664-1 on device level

Creepage considerations HV Q-DPAK



750V Gen1 Q-DPAK

Mold compound
CTI < 600
MG II

750V Gen2 Q-DPAK

Mold compound
CTI >600
MG I

Gen2

D-S Creepage

= ((15.3-10.23)/2 +0.9)

~ 3.43 (min)

MSL 1 → increased robustness againts moisture

DS creepage (min) 3.43 mm fulfills Vrms up to 630V for 750V
→ No additional coating steps needed on customer side.

Fulfilling requirements acc. to DIN EN 60664-1

Table F.4 – Creepage distances to avoid failure due to tracking

Voltage r.m.s. 1)	Minimum creepage distances								
	Printed wiring material								
	Pollution degree								
	1	2	1	2			3		
	All material groups	All material groups, except IIIb	All material groups	Material group I	Material group II	Material group III	Material group I	Material group II	Material group III 2)
V	mm	mm	mm	mm	mm	mm	mm	mm	mm
10	0,025	0,040	0,080	0,400	0,400	0,400	1,000	1,000	1,000
12,5	0,025	0,040	0,090	0,420	0,420	0,420	1,050	1,050	1,050
16	0,025	0,040	0,100	0,450	0,450	0,450	1,100	1,100	1,100
20	0,025	0,040	0,110	0,480	0,480	0,480	1,200	1,200	1,200
25	0,025	0,040	0,125	0,500	0,500	0,500	1,250	1,250	1,250
32	0,025	0,040	0,14	0,53	0,53	0,53	1,30	1,30	1,30
40	0,025	0,040	0,16	0,56	0,80	1,10	1,40	1,60	1,80
50	0,025	0,040	0,18	0,60	0,85	1,20	1,50	1,70	1,90
63	0,040	0,063	0,20	0,63	0,90	1,25	1,60	1,80	2,00
80	0,063	0,100	0,22	0,67	0,95	1,30	1,70	1,90	2,10
100	0,100	0,160	0,25	0,71	1,00	1,40	1,80	2,00	2,20
125	0,160	0,250	0,28	0,75	1,05	1,50	1,90	2,10	2,40
160	0,250	0,400	0,32	0,80	1,10	1,60	2,00	2,20	2,50
200	0,400	0,630	0,42	1,00	1,40	2,00	2,50	2,80	3,20
250	0,560	1,000	0,56	1,25	1,80	2,50	3,20	3,60	4,00
320	0,75	1,60	0,75	1,60	2,20	3,20	4,00	4,50	5,00
400	1,0	2,0	1,0	2,0	2,8	4,0	5,0	5,6	6,3
500	1,3	2,5	1,3	2,5	3,6	5,0	6,3	7,1	8,0 (7,9) 4)
630	1,8	3,2	1,8	3,2	4,5	6,3	8,0 (7,9) 4)	9,0 (8,4) 4)	10,0 (9,0) 4)
800	2,4	4,0	2,4	4,0	5,6	8,0	10,0 (9,0) 4)	11,0 (9,6) 4)	12,5 (10,2) 4)
1 000	3,2	5,0	3,2	5,0	7,1	10,0	12,5 (10,2) 4)	14,0 (11,2) 4)	16,0 (12,8) 4)

Defined by customer environment

Defined by mold compound
→ CTI > 600
→ MG 1 for QDPAK HV

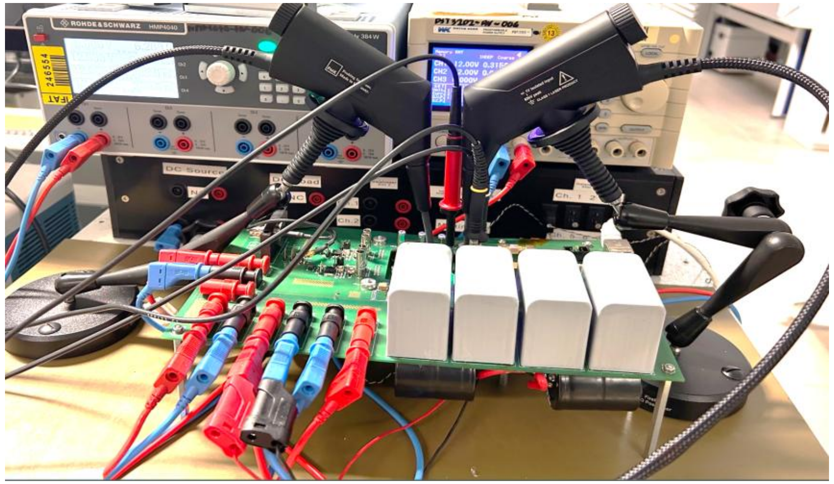
Table of contents

G2 vs G1 Q-DPAK application tests

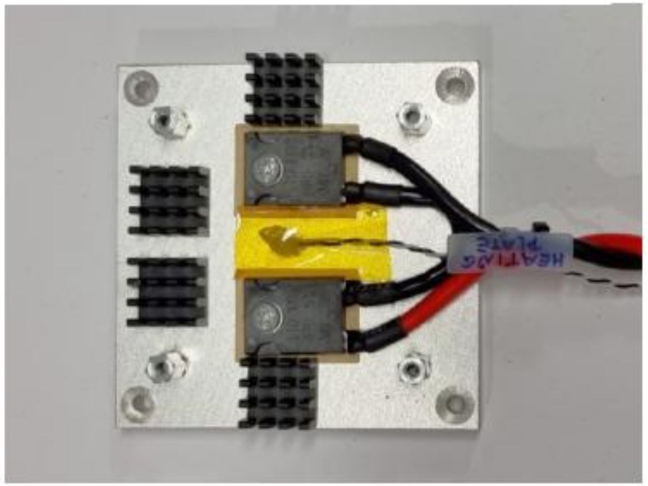
i) Dynamics (Double Pulse)
ii) Hard switching (PFC)
iii) Soft switching (LLC)

Half bridge board for double pulse test

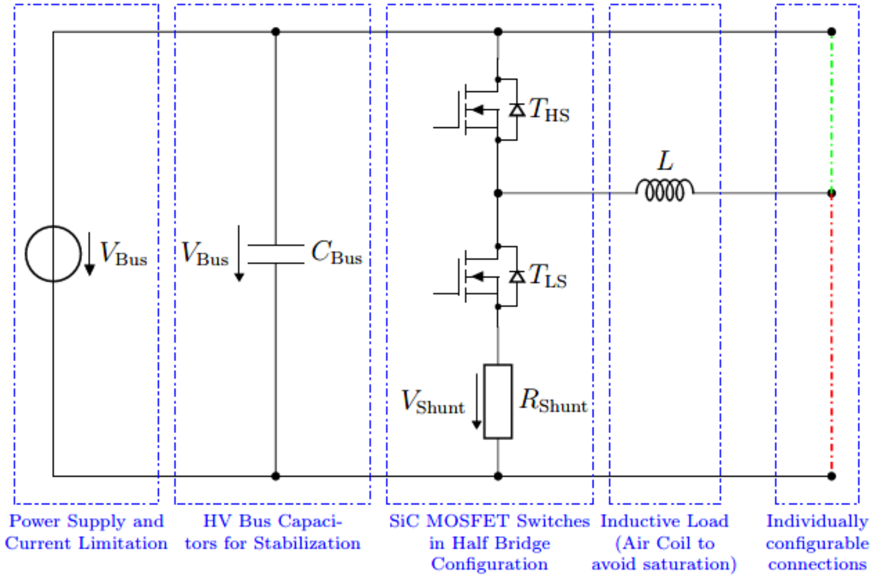
Test Setup



Heating Plate with 1 Ω 100 W Power resistors



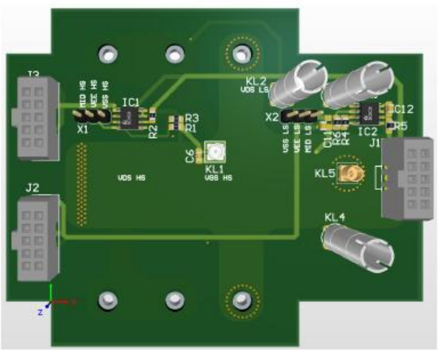
Concept Schematic -Double Pulse Test



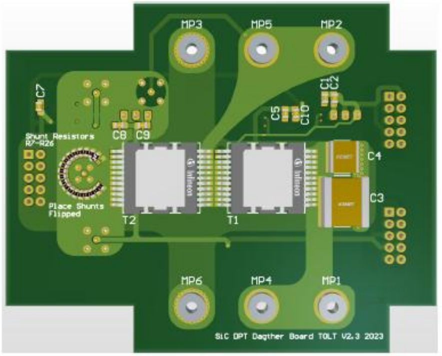
Equipment's Used :

- Programmable DC power Source chroma 62024P-600-8.
- Tektronix oscilloscope MSO56B, Probe PMK PHV 1000 & 3 Passive Probes
- Rhode & Schwarz HMP4040 for Power Resistors (Heating Plate).
- PID controller for heating the Resistors (100 W)

Daughter boards



(a) Top view



(b) Bottom view

Test Conditions

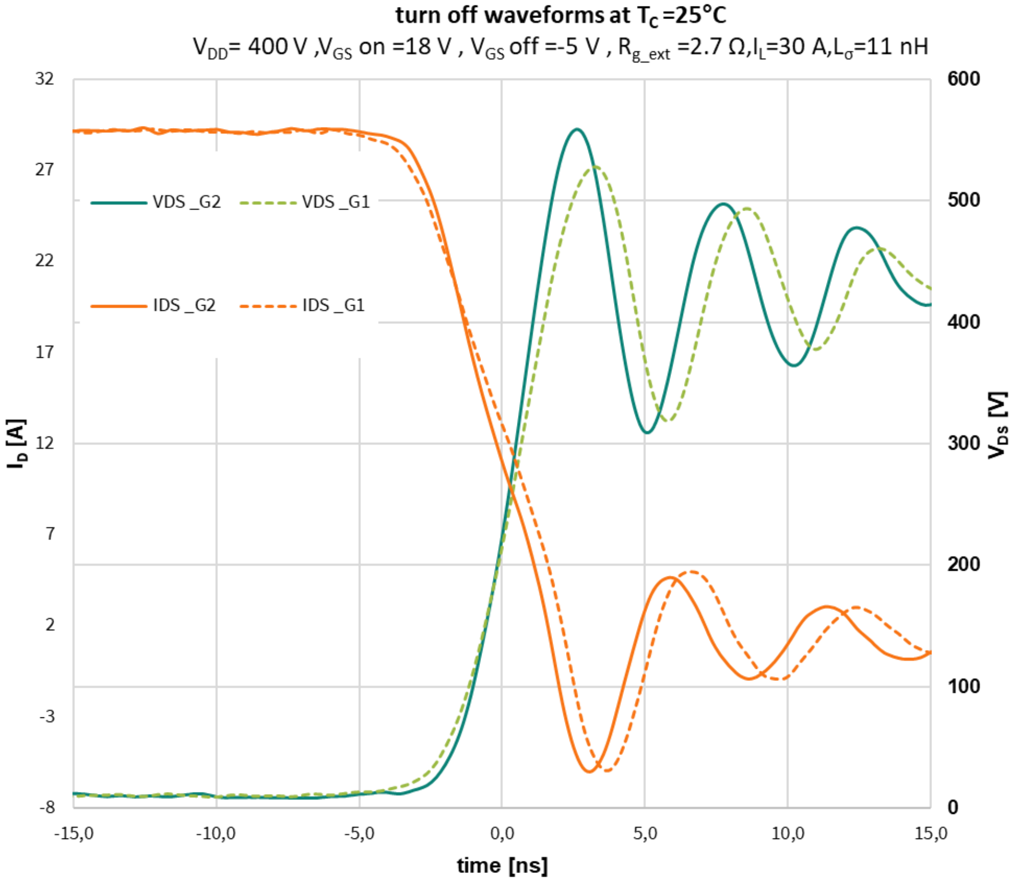
- V_{DD} = 400 V (Will be updated to 500 V)
- I_D = 5 A to 30 A
- R_g On/Off (Ext) = 2.7 Ω
- Shunts = 4.0 Ω (20 No's)
- V_{gs} = 18 V/-5 V

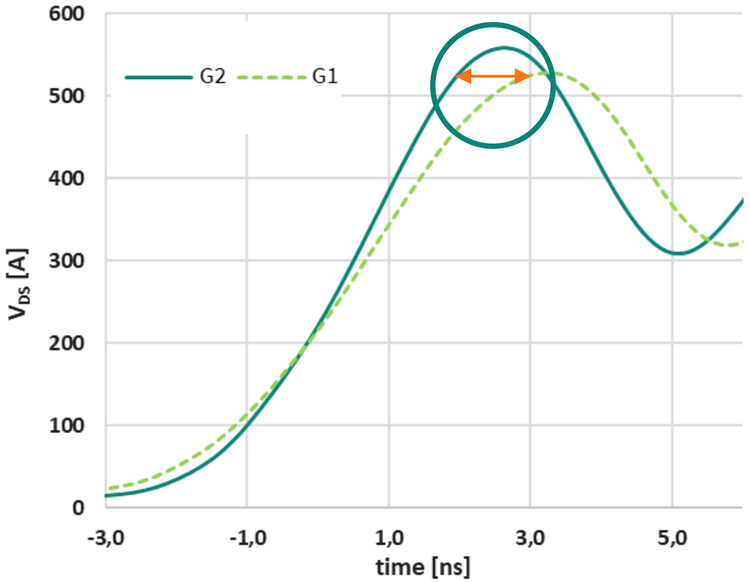
Parameters to be measured

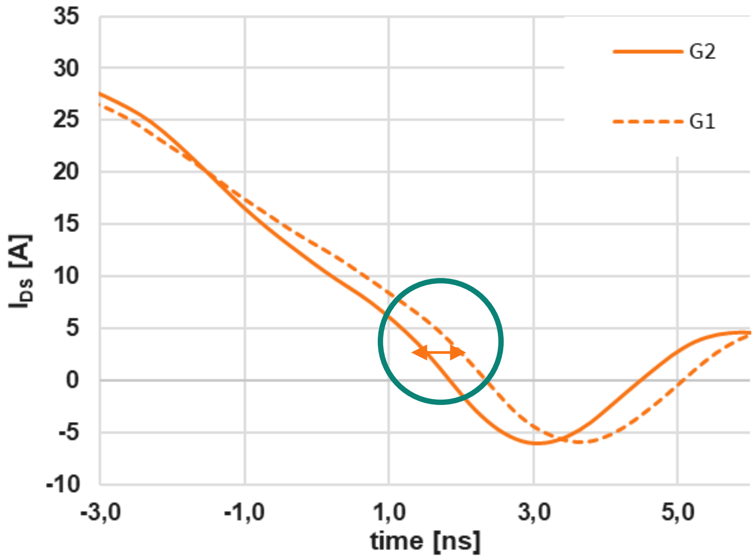
- E_{on} and E_{off}
  - 25°C
  - 150°C
- Q_{rr} at Typical I_D
  - 25°C
  - 150°C

Switching Behavior –**Turn-off**

G2 is 25% faster then G1







Voltage (V_{DS})
switching speed
during turn OFF

Gen 2 $\frac{dv}{dt} = 130V/ns$

Gen 1 $\frac{dv}{dt} = 103V/ns$

Current (I_{DS})
switching speed
during turn OFF

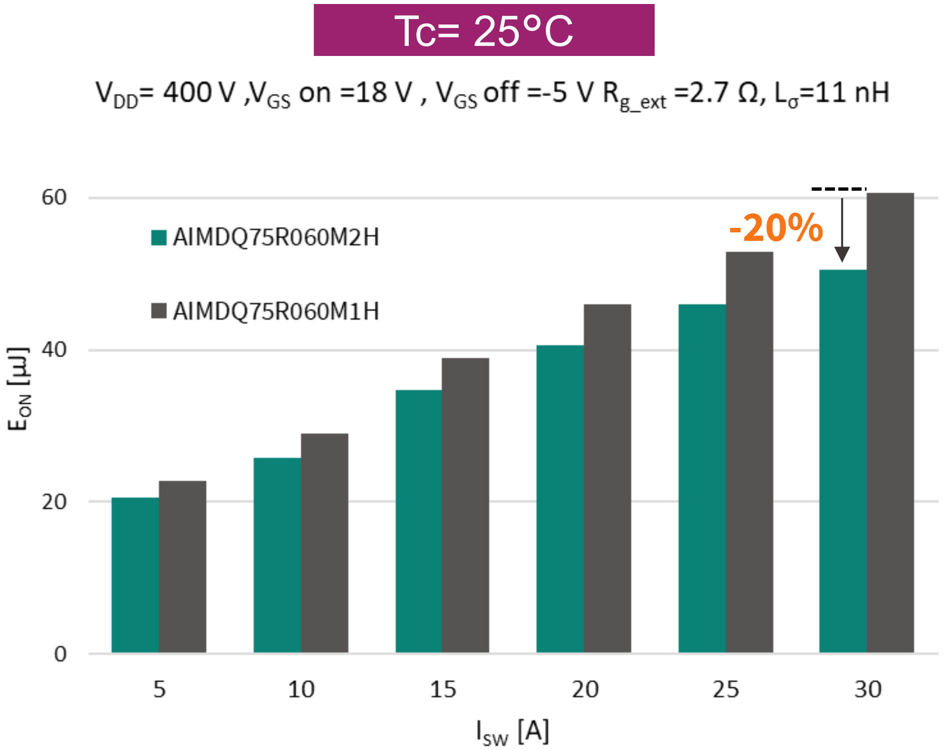
Gen 2 $\frac{dI}{dt} = 5.6A/ns$

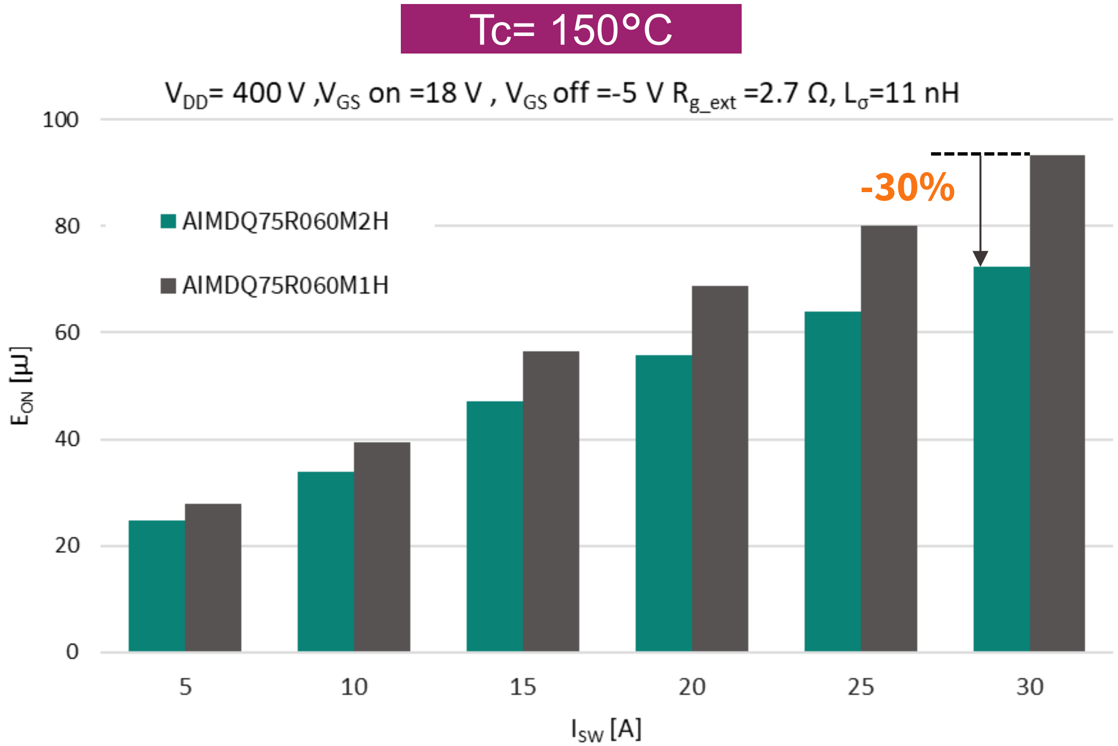
Gen 1 $\frac{dI}{dt} = 4.5A/ns$

Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

Switching energies G1 vs G2

Turn-on losses





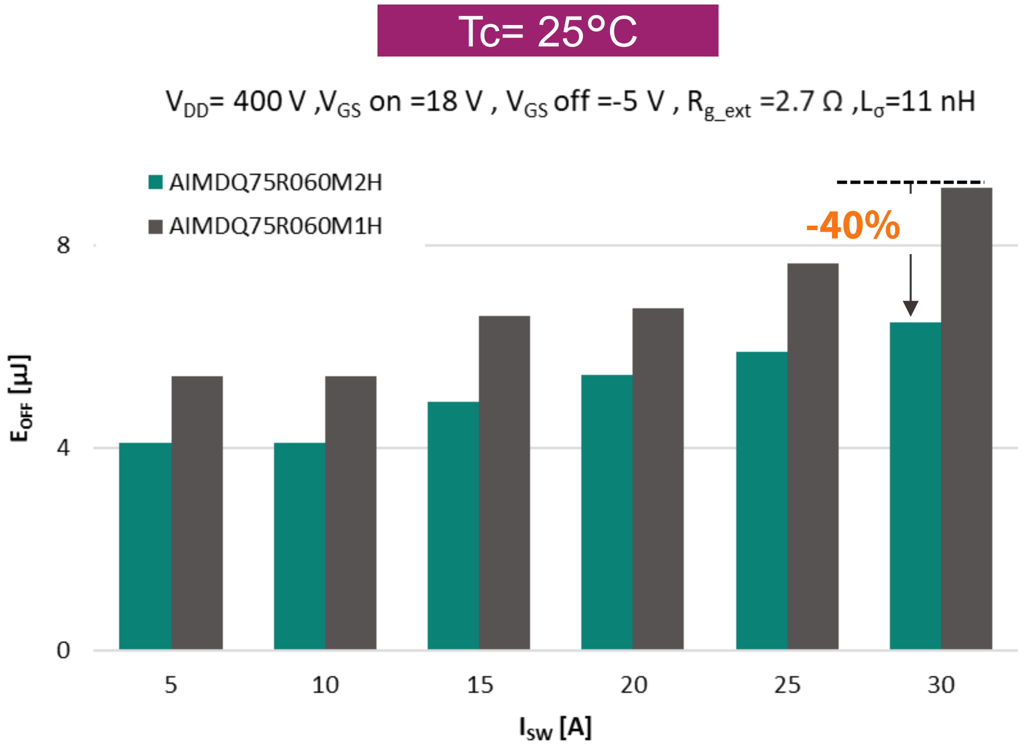
CoolSiC™ MOSFET 750 V G2 **device switches faster by 25% to 30%, lower turn on losses by 30% than G1**

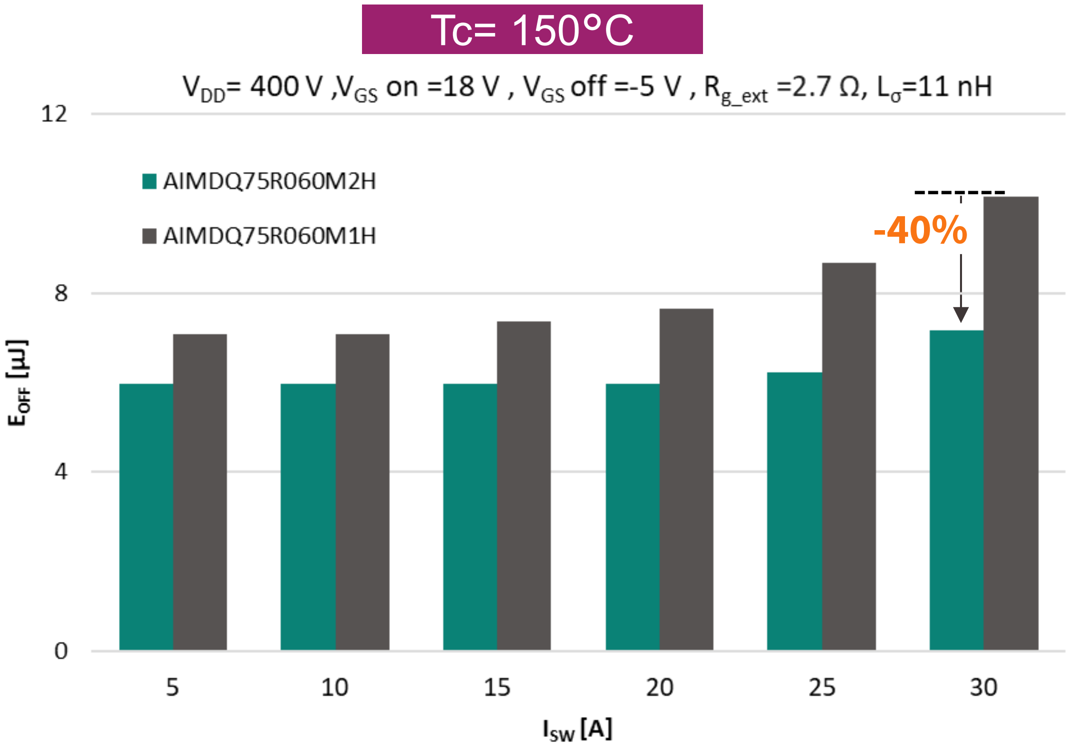
Note: turn off energy includes the $E_{OSS,}$ turn on energy does not include the E_{OSS}

Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

Switching energies G1 vs G2

Turn-off losses





CoolSiC™ MOSFET 750 V G2 **has significant lower turn-off loss than G1, by ~40%** at Tc=25°C and Tc=150°C

Note: turn off energy includes the E_{OSS}, turn on energy does not include the E_{OSS}

Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

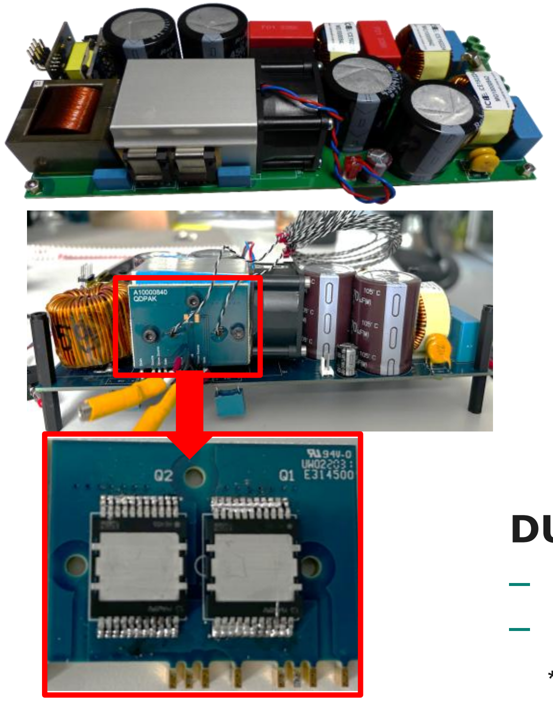
G2 vs G1 Q-DPAK application tests

i) Dynamics (Double Pulse)
ii) Hard switching (PFC)
iii) Soft switching (LLC)

CoolSiC™ G2: a new level of performance in full-load operation

measurement result from Totem Pole PFC – EVAL_3K3W_TP_PFC_SIC

Totem Pole PFC – EVAL_3K3W_TP_PFC_SIC



Daughter Board

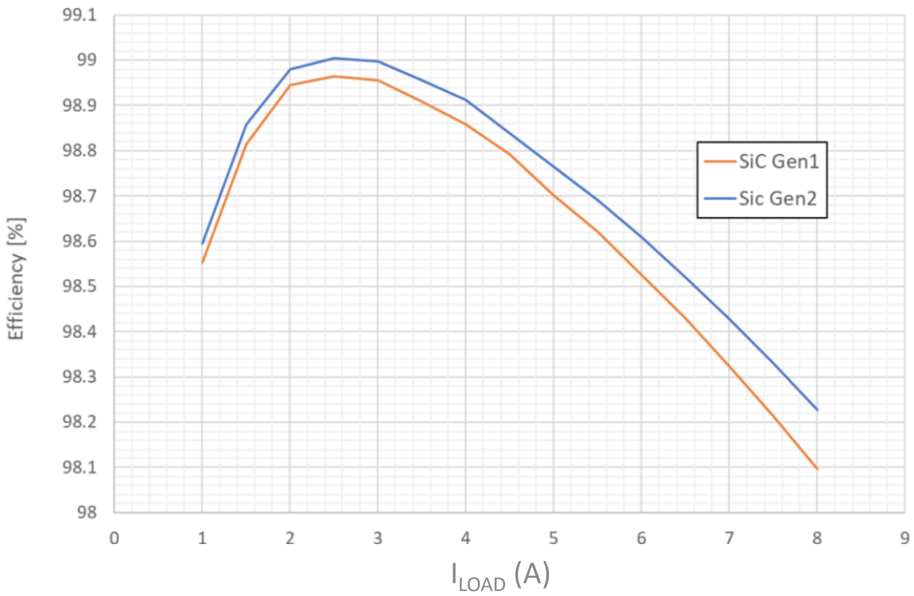
Operating Conditions

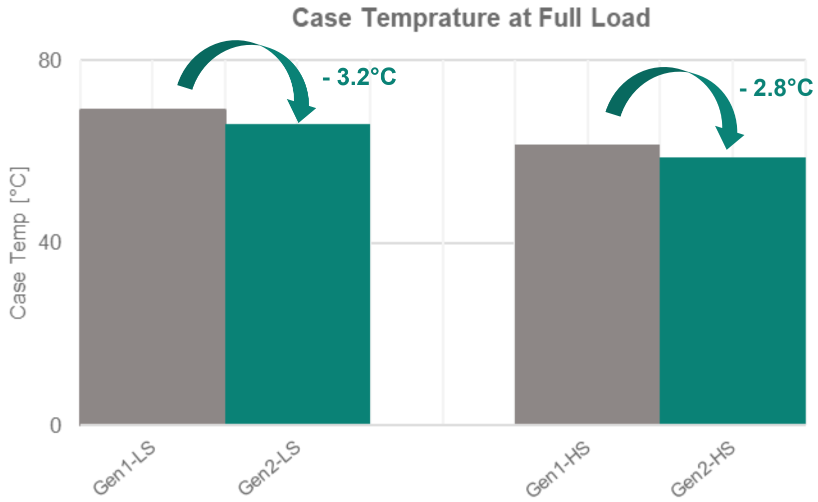
- V_{in}=230 V
- V_{out}=400 V
- Iout = 1 to 8A
- f_{sw}=65KHz CCM
- Hard-switching PFC
- Unipolar driving voltage: 0 V / 18 V

DUTs:

- Gen 1 AIMDQ75R060M1H (Q-DPAK)
- Gen 2 AIMDQ75R060M2H (Q-DPAK)*

*EES used for this test



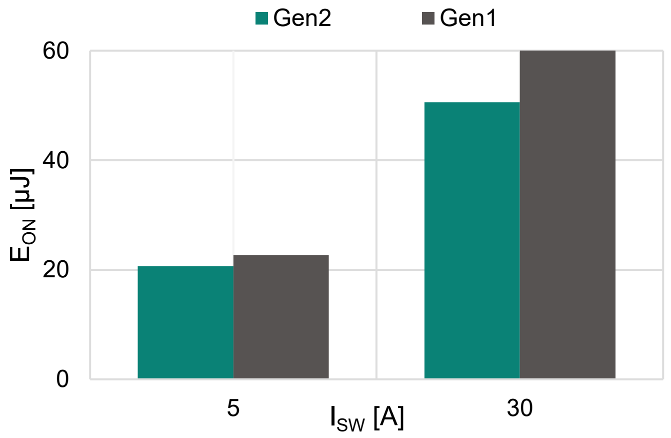


- CoolSiC™ 750 V G2 has less power consumption than CoolSiC™ 750 V G1 at all frequencies **by ~ 0.15% at full load and ~ 0.05% at light loads.**
- CoolSiC™ 750 V G2 has less temperature rise than CoolSiC™ 750 V G1 **at full load by ~ 3°C.**

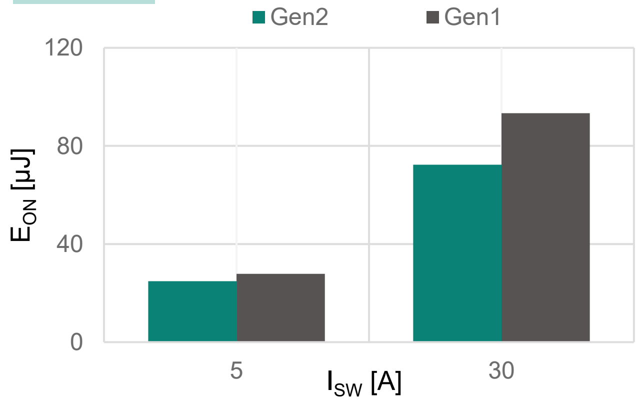
Hard-Switching PFC stage (impact of Turn on losses)

Turn-on losses (hard sw.)

T_C =25°C

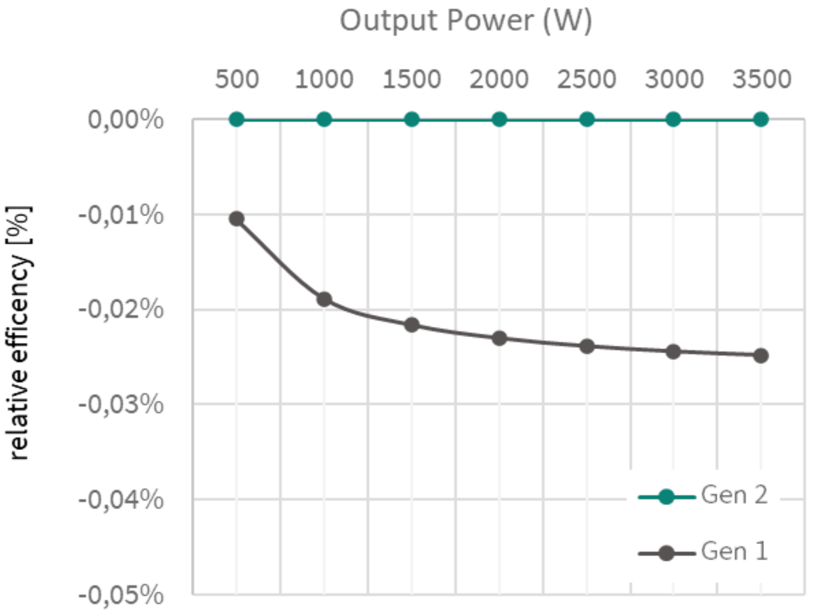


T_C =150°C



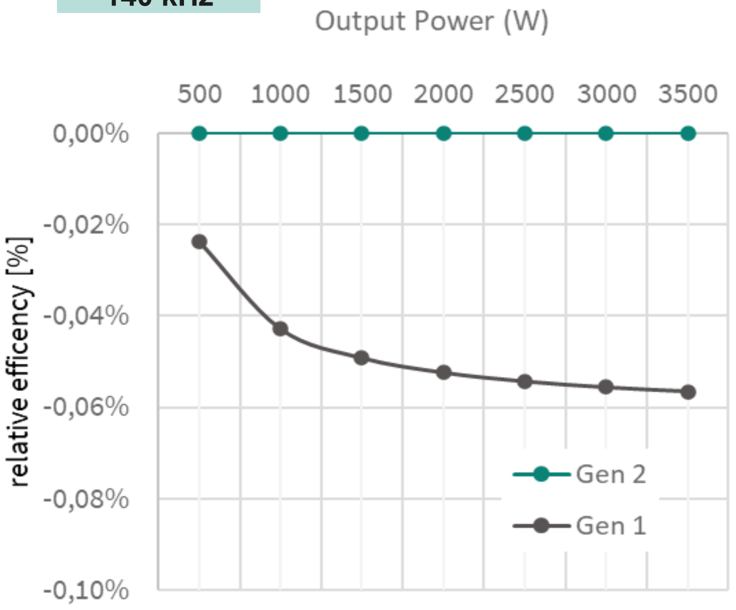
Application results

65 kHz



Tj = 100ºC, V_{in} = 176V, $R_{ds,on}$ = 60mΩ_{typ}

140 kHz



Tj = 110ºC, V_{in} = 176V, $R_{ds,on}$ = 60mΩ_{typ}

- Dynamic performance comparing Infineon CoolSiC™ G1 and G2
- G2 shows **significant advantages at higher f_{sw} and higher power in hard-switching topologies**

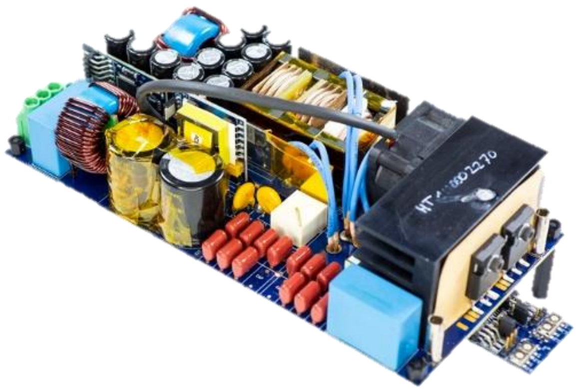
Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

G2 vs G1 Q-DPAK application test

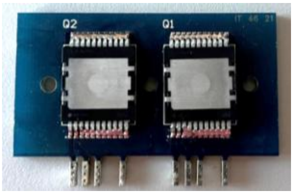
i) Dynamics (Double Pulse)
ii) Hard switching (PFC)
iii) Soft switching (LLC)

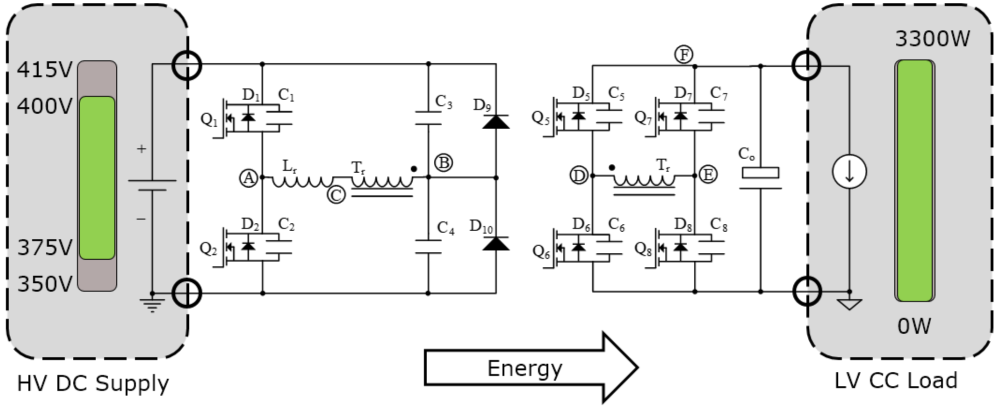
3.3 kW LLC Converter

3.3 kW LLC Converter Board



Daughter Board





Board Description

- DC/DC converter
  - 400 V nominal input voltage (350 V-415 V)
  - 8.25 A nominal input current
- 43.5 V – 59.5 V output voltage
  - 51.5 V nominal output voltage
  - 65 A nominal output current
- up to 3300 W output power
- Efficiency tested with dotnet Efficiency
- Frequency range 75 kHz – 107 kHz
- Unipolar driving 0 V/18 V

DUTs:

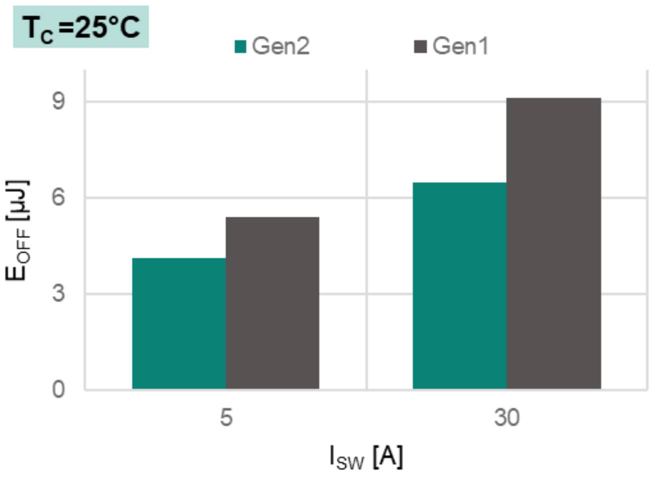
- G1 AIMDQ75R060M1H
- G2 AIMDQ75R025M2H*

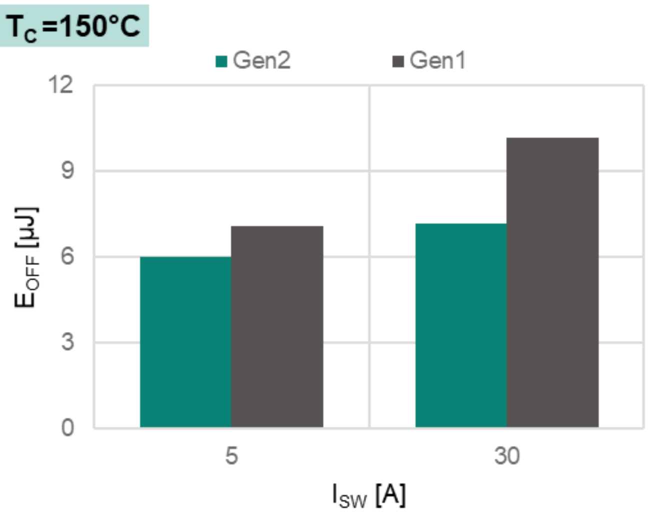
**EES used for this test are not based on final process.*

- A detailed description of this board is available in this Application Note.
- The turn ratio of the pulse transformer TR-2 has been modified (13:16:16 ➔ 13:20:20) to generate the 18 V driving voltage.

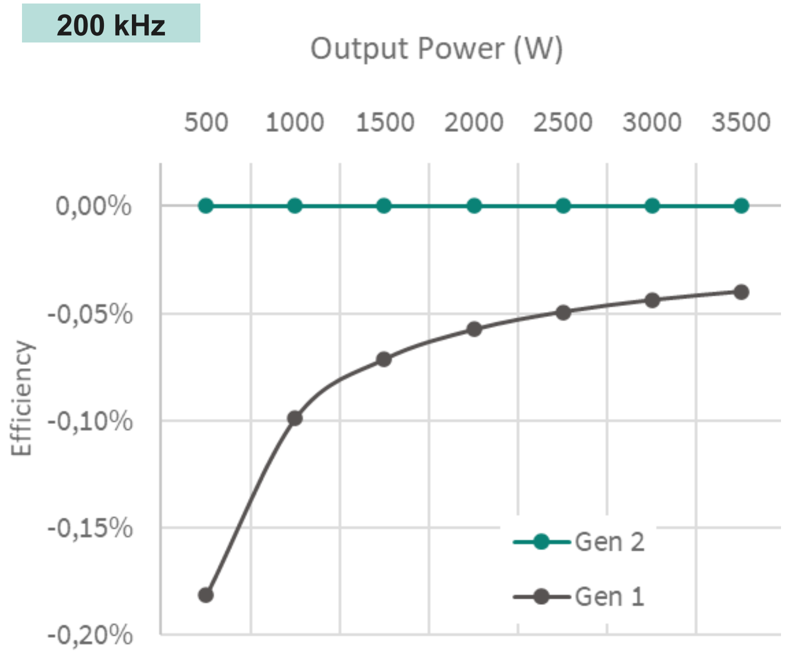
Soft-switching LLC (impact of turn off losses)

Turn-off losses (soft sw.)

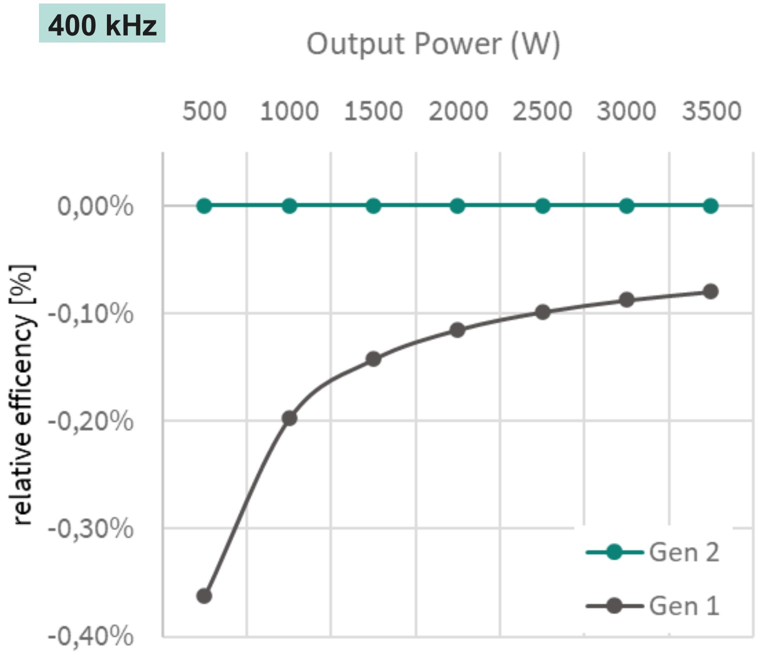




Application results



Tj = 100°C, $R_{ds,on}$ = 60mΩ_{typ}



Tj = 100°C, $R_{ds,on}$ = 60mΩ_{typ}

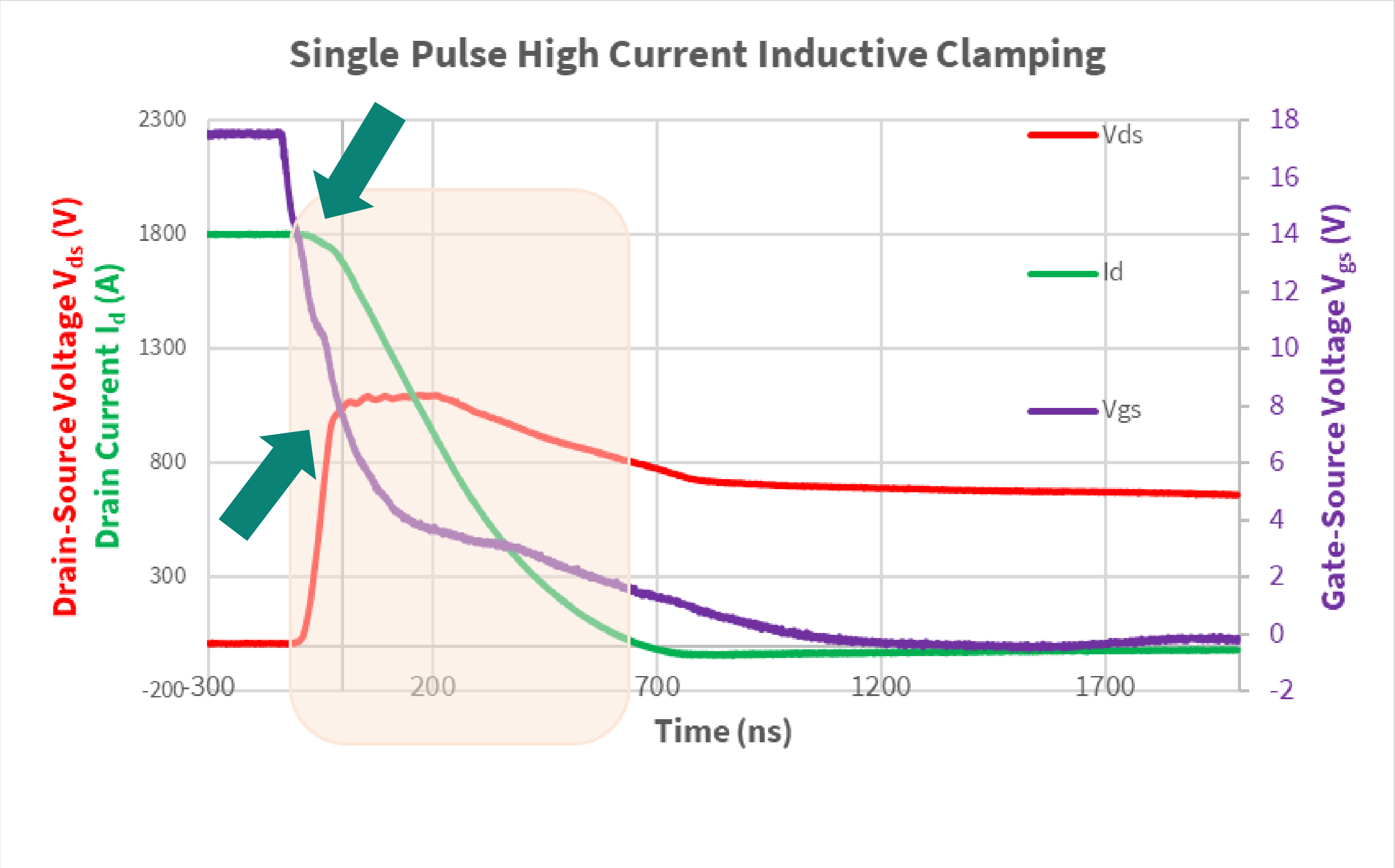
Infineon CoolSiC™ G2 demonstrates a **substantial improvement in soft-switching topologies**, addressing the lower efficiency than G1

Source: Application Note- AN125027 CoolSiC™ 750 V G2 automotive MOSFET

G2 ultra-low ohmic for static application

high current avalanche test

High current avalanche measurements



- Crucial for static switching applications
- Results with best-in-class **IMDQ75R004M2H**
- Device can **withstand the maximum peak rated current**

IMDQ75R004M2H

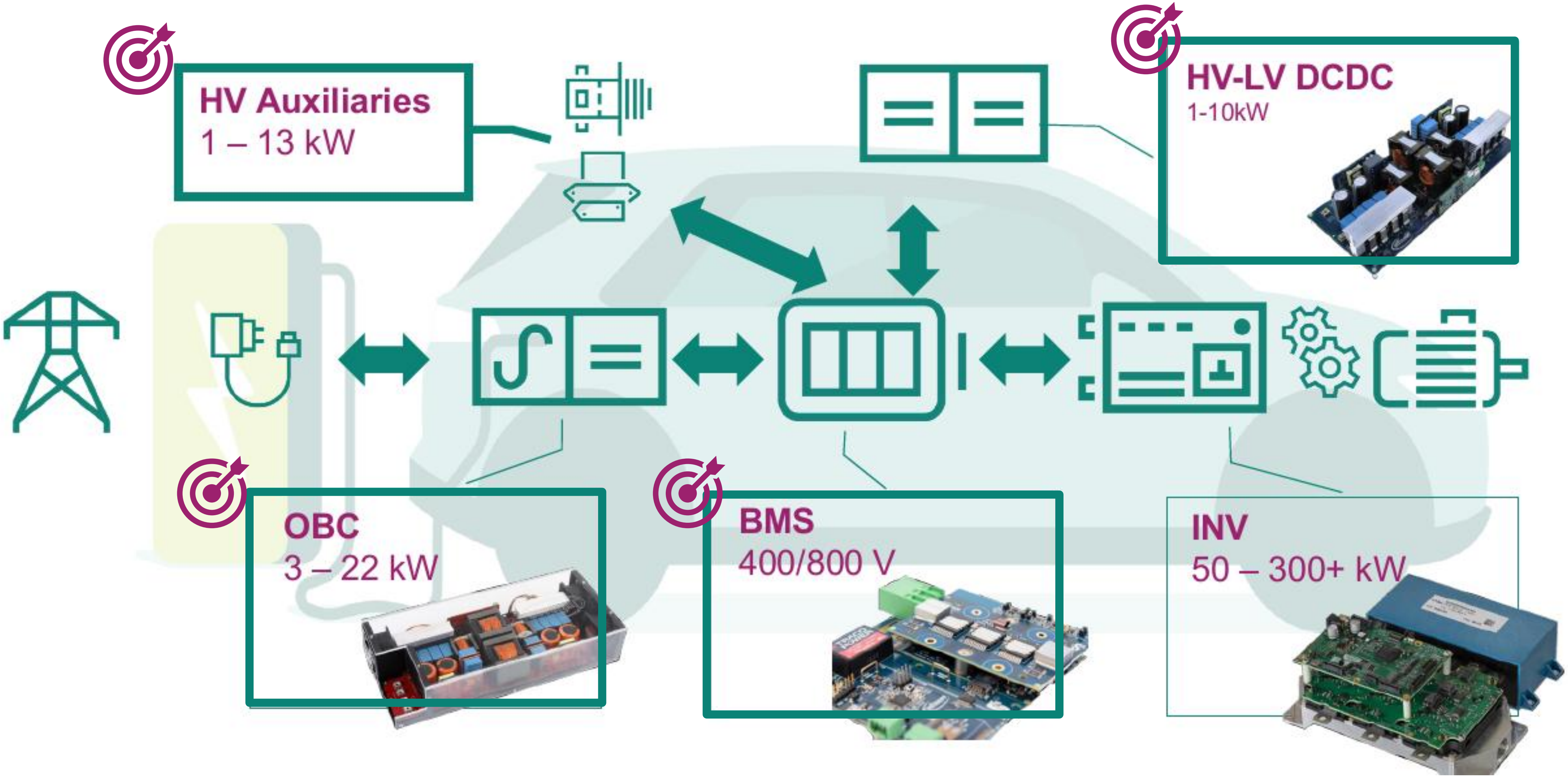
Key parameter from Datasheet

Parameter	Value	Unit
V_{DSS} over full $T_{j,range}$	750	V
$R_{DS(on),typ}$	3.5	mΩ
$R_{DS(on),max}$	5	mΩ
$Q_{G,typ}$	342	nC
$I_{D,pulse}$	1699	A

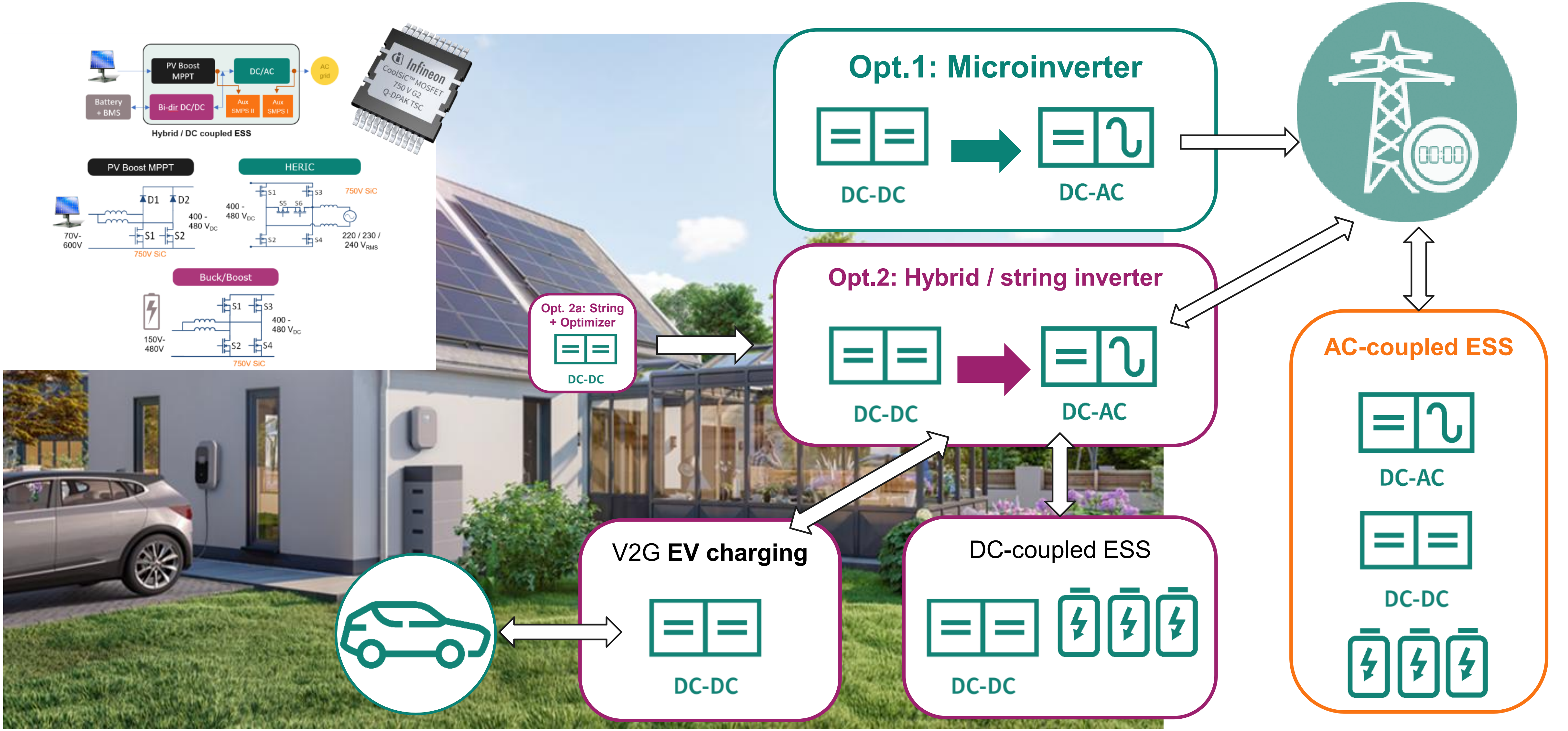
https://www.infineon.com/assets/row/public/documents/24/49/infineon-imdq75r004m2h-datasheet-en.pdf

Table of contents

Infineon enables electric drive train application with system competence powered by CoolSiC™ MOSFETs



750 V SiC Gen 2 delivers higher system efficiency in residential ecosystem at lower cost



Infineon enables electric drive train applications with system competence powered by CoolSiC™ MOSFETs

OBC trends

Performance increase
3.6 kW to 11 / 22 kW

Power density increase
2 kW/L to 10 kW/L

Higher Efficiency
95% to >97%

Bidirectionality
V2G, V2X

Scalable batteries 400 V & 800 V
Faster charging

Power electronics

CoolSiC™

SiC

High performance

- **Excellent switching performance**
- **Optimal thermal conductivity**
- **.XT technology – die attach**
  Improved thermal performance

High reliability

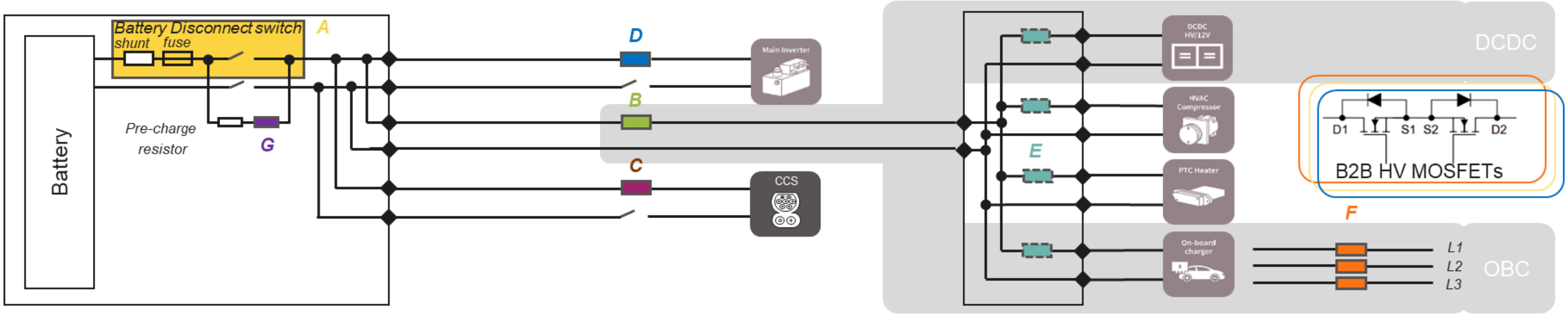
- **Chip reliability**
  trench technology, Gate-oxide reliability
- **Package reliability**
  performance under mechanical &thermal stress
- **Infineon quality**
  More stringent approach beyond standards

Ease-of-use

- **Mature technology**
  Reduced design complexity

From mechanical switch to semiconductor solutions: Automotive HV Power distribution

1 In BMS	3 In a Junction box	2 In Auxiliaries



A: Battery disconnect switch (BDS)

G: Pre-charge SSR

B: Central eFuse for auxiliaries

C: DC fast charging

D: Traction Inverter Disconnect Switch

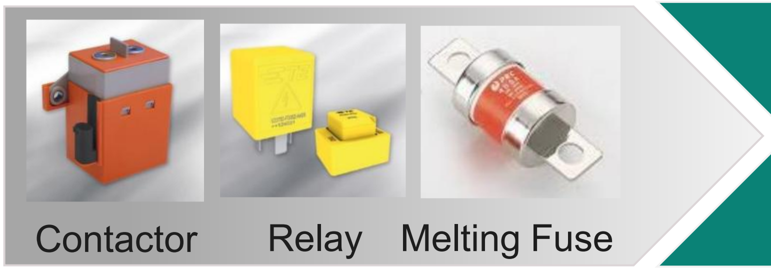
E: Auxiliary eFuse (optional)

F: AC input relay

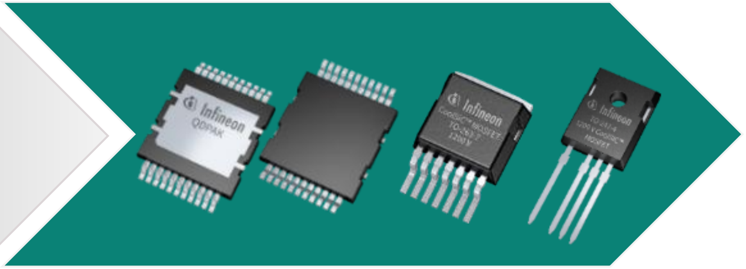
750V CoolSiC™ G2
AIMDQ75R004M2H AIMDQ75R007M2H

Best-in-class $R_{DS(on)}$

From state-of-the-art to…



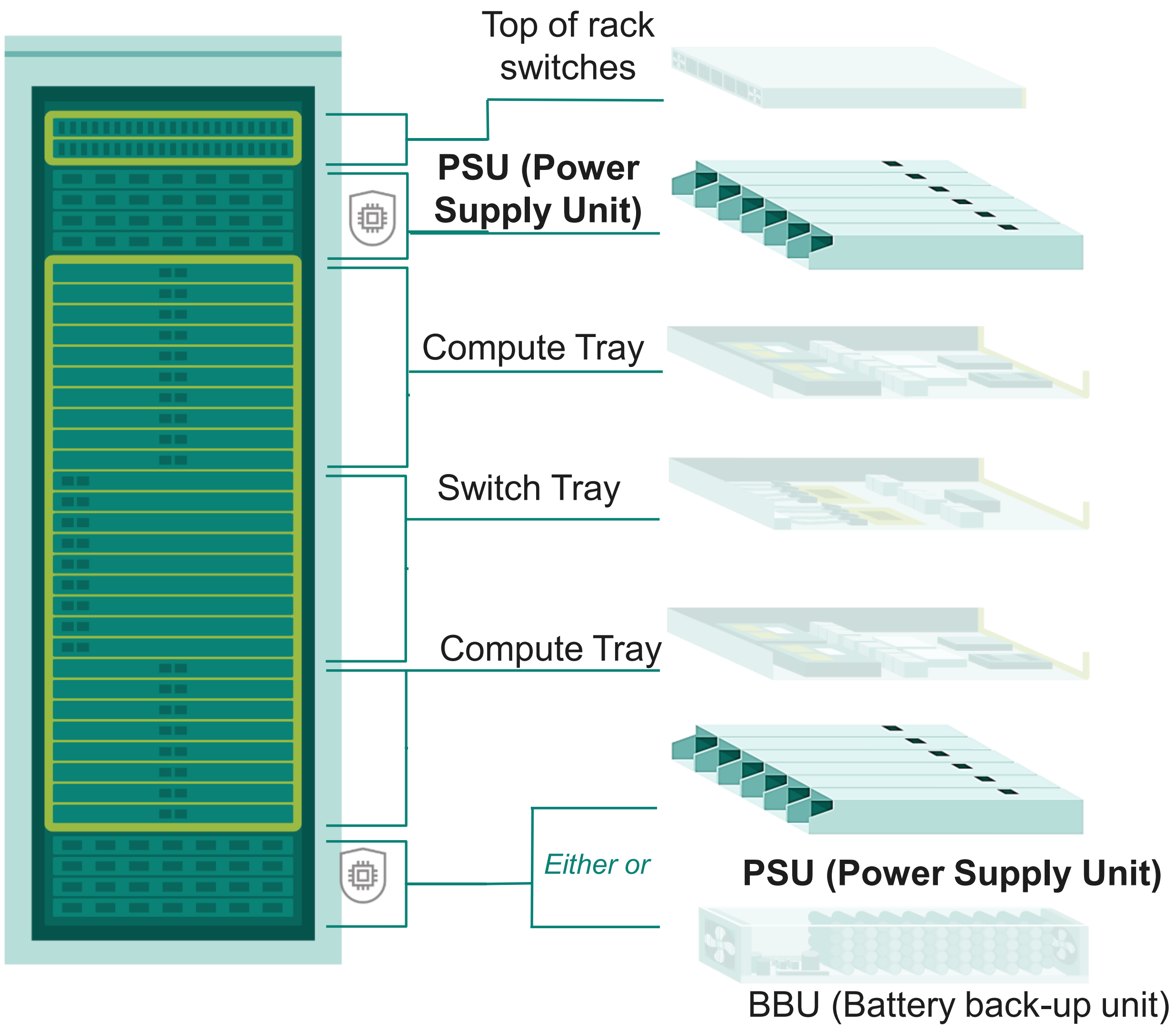
Power Semiconductor Switch



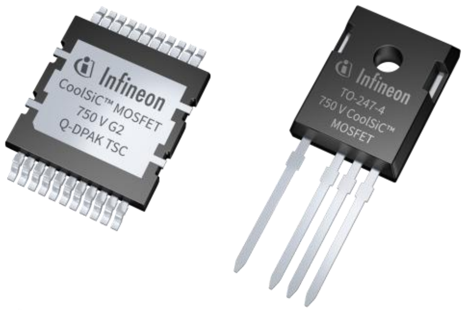
“Infineon is already tackling this challenge, leveraging its SiC portfolio and tailoring different solutions for BDS and eFuse“

AI server SMPS trends

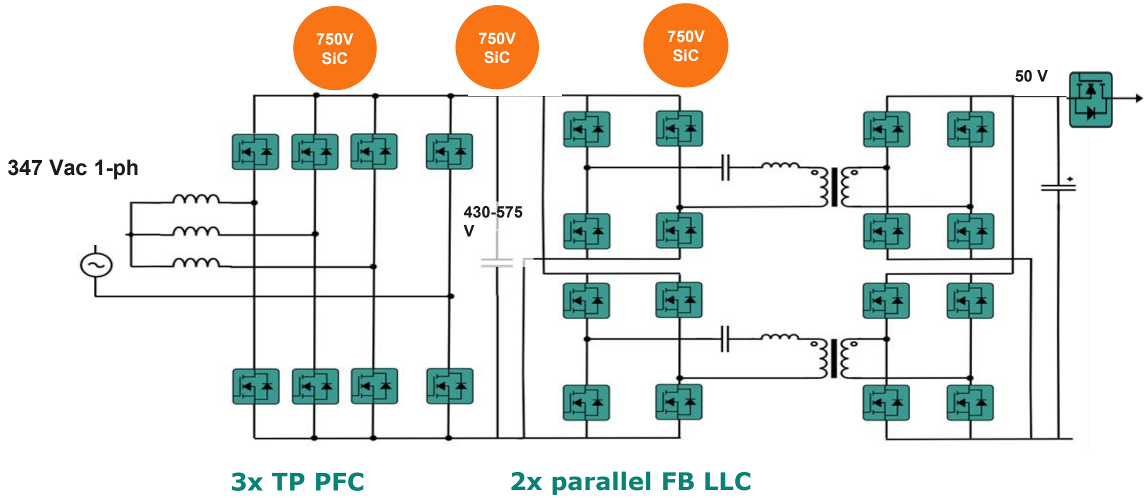
Power	PSU >5.5 kW; Rack 100-300 kW, 500 kW+ on horizon
Density	PSU >80 W/in^3
Efficiency	>97.5%
Dynamic load	GPU high peak load transient requires higher LLC frequency and dynamics
AC voltage distribution	Move from 1-phase to 3-phase PSU to SST
DC voltage distribution	Bus voltage increase from 50 to ±400V/800V
Cooling	Immersion / direct liquid / cold plate cooling needed for 100+ kW racks



1-3-ph – 8…30 kW PSU designs for AI demands will be enabled by WBG technologies. 750V SiC G2 fits in well with faster switching

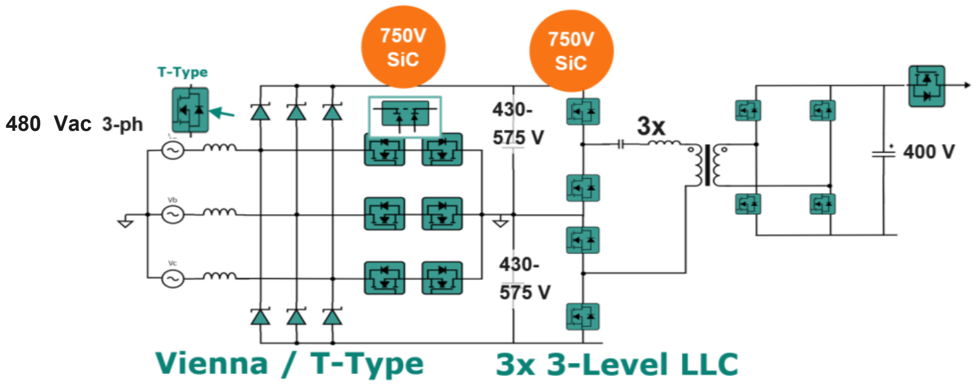


Increased line voltage for higher power



~8–12 kW, 50 Vout, 347 Vac 1-ph

3-ph for highest power



~25-30 kW 400 Vout 480 Vac 3-ph

Table of contents

Superior Infineon Automotive quality
Qualification tailored to SiC specific failures

SiC Quality Excellence

CoolSiC™

1 Design

- **Gate oxide reliability**
  Video available here
- **Robustness against parasitic turn-on**
- **High Vgs,th >4V**
- **Wide V_{GS} range with 0 V turn-off V_{GS}**
- **Avalanche capability**
- **High breakdown voltage**

Infineon automotive approach

2 Qualification

Extended reliability requirements

Robust packages

3 Production monitoring

Y_B screening

Part average test (PA)

Statistical bin alarm (SBA)

Gate oxide screening

100% avalanche testing in BE implemented if specified in the datasheets

+

AEC Q101 reliability/qualification requirements

- Qualification **well beyond AEC Q101** standards
- **Zero defect target** in automotive application conditions
- Approach in place for > 10 years

Automotive CoolSiC™ is designed to achieve high reliability

Infineon Quality Policy
Highest quality and reliability in Si and SiC MOSFETs

We do what we promise.
That's quality made by Infineon.

- We differentiate as quality leader.
- Quality means to us: zero defect regarding our commitments.
- All Infineon employees act as quality advocates in their areas of responsibility.
- We follow our Quality Principles.

CoolMOS™ Automotive Technologies	CoolSiC™ MOSFET Technologies
– **<0.01 DPM** on average – Only 1 fail in >326 Mio parts shipped in last 7 years	– **Zero** systematic technology or assembly issues in last 7 years, > 42 Mio parts shipped*

All SiC MOSFETs shipped all grade

Table of contents

Multiple supply sources along with capacity invest secure long-term success and high-volume production

SiC | Manufacturing know-how and supply security

Global multi-country sourcing strategy for SiC wafers and boules

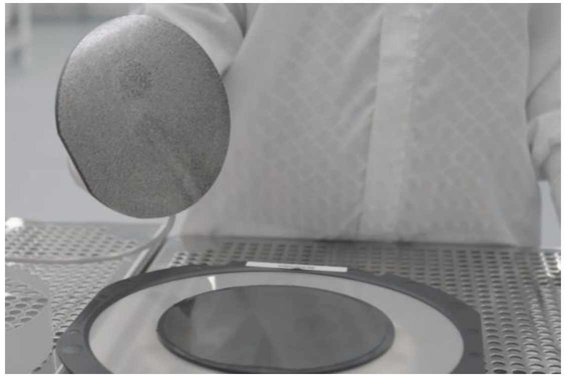
Industrialization of Cold Split Technology

Invest in in-house capacity in Villach and Kulim

Raw material supply security

- Close cooperation with established suppliers
- Continuous screening of the market for new suppliers

Increase productivity



- Acquisition of SILTECTRA™
- Cold Split Technology of SILTECTRA™ allows separation of crystal material with minimal material losses (Video)

In-house capacity ramp

- Expansion of SiC capacity in Villach & Kulim
- Villach ramping up, Kulim construction started
- Product roll-out based on 200mm starting Q1 CY25

Smart phase-over and ramp-up of 200 mm volume production to enable next level of innovation for customer value with SiC

SiC — Manufacturing know-how and supply security

Villach **Kulim**

Pilot projects on track

- Qualification on selected high-volume technologies nearly finished
- SiC multi-country sourcing strategy for raw materials in place
- Wafer yield equal or better to 150mm

Smart 200mm phase-over

- Volume production in Villach and Kulim
- Cleanroom and tools already available
- Full transition to 200mm within 3 years after qualification planned

Timeline

- Product roll-out based on 200mm starting Q1/2025
- Major new chip developments on 200mm

Table of contents

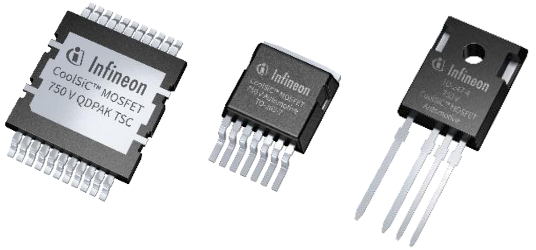
750 V CoolSiC™ MOSFETs Generation 2

to revolutionize automotive and industrial power conversion

Key benefits

- **Highly robust 750 V technology**, 100% avalanche tested
- Unparalleled **switching performance with FoM >25% at 25°C** improvement over the previous generation
- **Unipolar gate driving** to simplify the system design with superior immunity against parasitic turn-ons
- Increased flexibility on driving voltage with **wider $V_{gs(static)}$ -7 V to 23 V**
- **Unique robustness in overload condition** with **extended T_{vj} = 200°C**
- **Short circuit robustness**
- **Maximum $R_{DS(on)}$ at T_j = 150°C** specified in datasheet

$R_{DS(on,typ)}$ @25 °C
4 mΩ - 60 mΩ



new

Automotive: On-board charger | HV-LV DC-DC converter | eFuses e-Disconnect | HVAC compressor | PTC heating

Industrial: EV charging | Server | Telecom | Solar | Energy storage | SSCB

CoolSiC™ MOSFET G2 750 V Automotive and Industrial

A broad discrete SiC MOSFET portfolio with a new innovative TSC package

Infineon

750 V CoolSiC™ G1

TSC

Q-DPAK
8 products
8mΩ - 140 mΩ

TO-247-4
8 products
8mΩ - 140 mΩ

D²PAK-7
7 products
8mΩ - 140 mΩ

CoolSiC™ G2 released

TSC

Q-DPAK
10 products
4mΩ - 60 mΩ

D²PAK-7
9 products
7mΩ - 60 mΩ

750 V CoolSiC™ G2 upcoming

TO-247-4
9 products
7mΩ - 60 mΩ

TSC new
More TSC Package

750 V CoolSiC™ Generation 2

Technology	CoolSiC™ MOSFETs 750 V Generation 2		
Grade	Automotive + Industrial		
$R_{DS(on,typ)}$ [mΩ] (25 °C)	Q-DPAK TSC	D2PAK-7L	TO247-4
60	AIMDQ75R060M2H	AIMBG75R060M2H	AIMZA75R060M2H
new 50	AIMDQ75R050M2H	AIMBG75R050M2H	AIMZA75R050M2H
40	AIMDQ75R040M2H	AIMBG75R040M2H	AIMZA75R040M2H
new 33	AIMDQ75R033M2H	AIMBG75R033M2H	AIMZA75R033M2H
25	AIMDQ75R025M2H	AIMBG75R025M2H	AIMZA75R025M2H
20	AIMDQ75R020M2H	AIMBG75R020M2H	AIMZA75R020M2H
16	AIMDQ75R016M2H	AIMBG75R016M2H	AIMZA75R016M2H
new 11	AIMDQ75R011M2H	AIMBG75R011M2H	AIMZA75R011M2H
7	AIMDQ75R007M2H	AIMBG75R007M2H	AIMZA75R007M2H
Best-in-class $R_{DS(on)}$ 4	AIMDQ75R004M2H	-	-
SOP	Released	Released	Upcoming

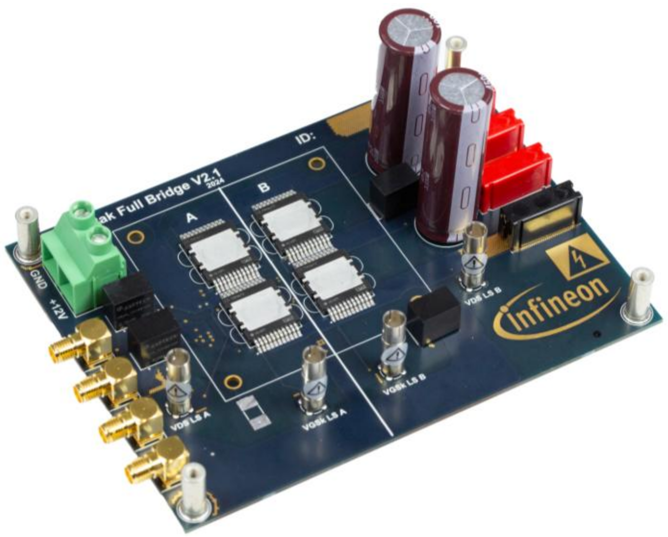
Applications

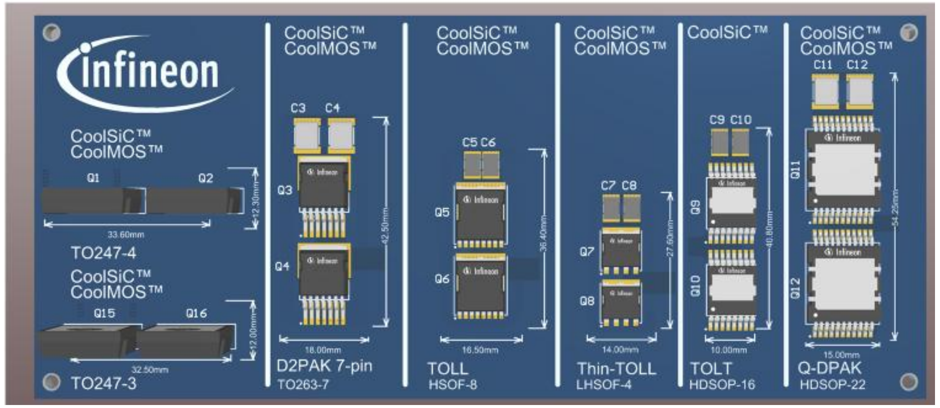
Automotive: On-board charger, HV-LV DC-DC converter, eFuses e-Disconnect, HVAC compressor, PTC heating

Industrial: EV charging, Server, Telecom, Solar, Energy storage, SSCB

Table of contents

Eval Boards





Evaluation board for Q-DPAK

- **Simple eval board** showing how to use SiC MOSFETs in Q-DPAK.
- **Flexible board** to evaluate TSC devices electrically and thermally in customer's lab.
- **a reference layout with optimized power- and gate-loop design**.

S. No	Hero Part
1	AIMDQ75R016M2H
2	2EDB9259Y

Released	Link

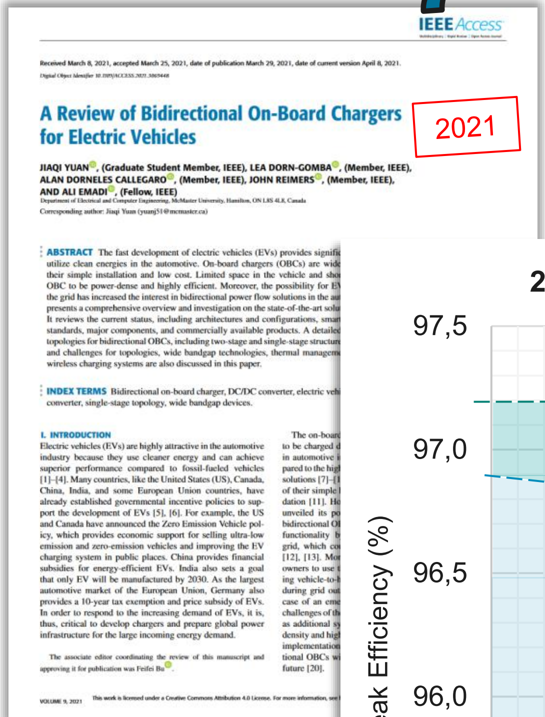
DEMO_HV_PACKAGE

- Innovative cooling concepts: BSC& TSC
- **Optimized design of half bridge**
- **Lower stray inductance**
- Faster in production assembly
- Higher switching capability
- Better control and reduced power losses

S. No	Hero Parts
1	CoolSiC^{TM}
2	CoolMOS^{TM}

Released	Link

Automotive tiny power box vs. SoA – successfully demonstrated the potential of SiC and TSC packages to disrupt EV-charging


IEEE Access

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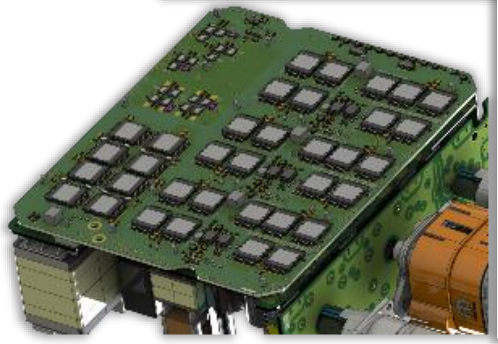
A Review of Bidirectional On-Board Chargers for Electric Vehicles

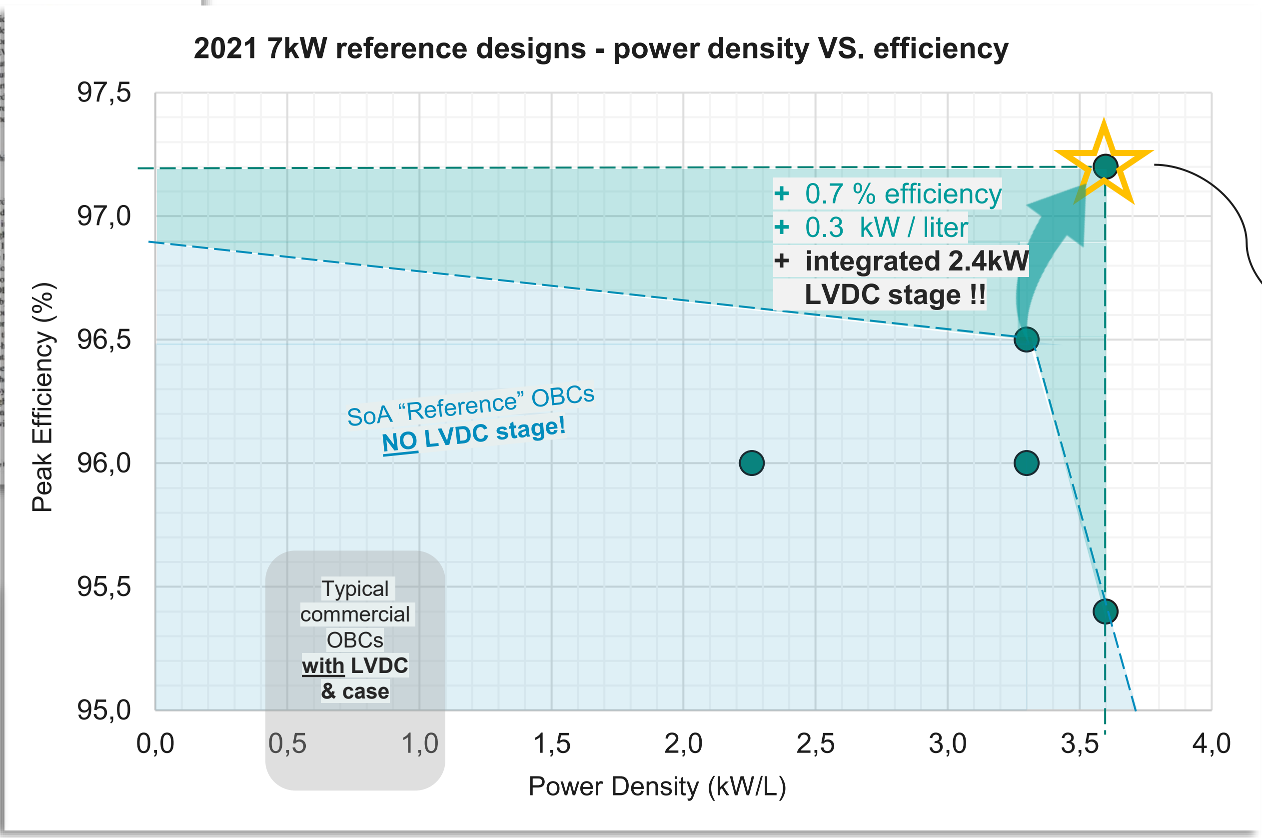
JIAQI YUAN, (Graduate Student Member, IEEE), LEA DORN-GOMBA, (Member, IEEE), ALAN DORNELES CALLEGARO, (Member, IEEE), JOHN REIMERS, (Member, IEEE), AND ALI EMADI, (Fellow, IEEE)

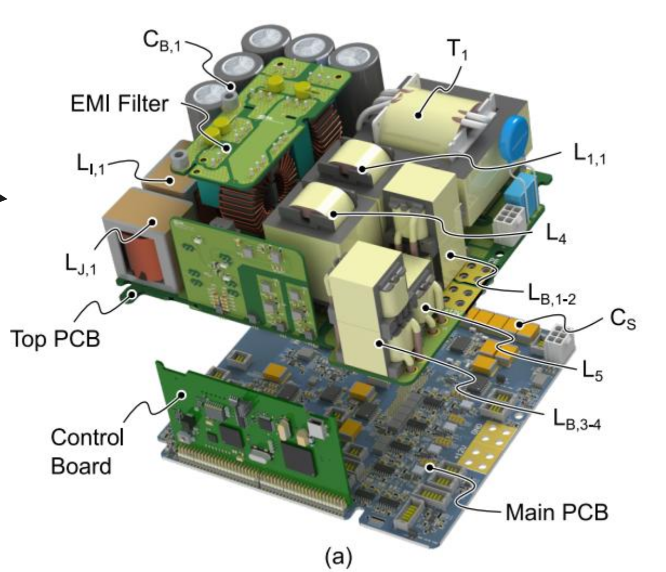
2021

Manufacturer	PFC Topology	DC/DC Topology	Input Voltage (V)	Output Voltage (V)	Power (kW)	Efficiency (%)	Power Density (kW/L)	Switching Devices	Cooling Method	Aux. LVDC Stage
Texas Instruments	Totem pole	CLLC	208-240	250-450	6.6	97	-	SiC	-	no
Delta-q	Totem pole	CLLC	85-265	250-450	6.6	96	2.26	SiC/GaN	Liquid	no
Wolfspeed	Totem pole	CLLC	-	250-450	6.6	96.50	3.3	SiC	-	no
Current Ways	Three-phase full-bridge	DAB	97-265	250-425	6.6	96	3.3	SiC	Liquid	no
Silicon Austria Labs	**Totem pole**	**CLLC**	**85-265**	**250-450**	**7.0**	**97.2** ★	**3.6** ★	**SiC/Si**	**Liquid**	**YES – 2.4kW** ★

Without housing/casing!!







Check out our additional information to get a deeper understanding of our SiC discretes and the benefits for your application!

Collaterals and brochures
- Product briefs
- Application brochures
- Presentations
- Press releases

Technical material
- Application notes
- Technical articles
- Simulation models
- Datasheets, MCDS files

Hardwares
- Evaluation boards

Training
- Training Videos

https://www.infineon.com/products/power/mosfet/silicon-carbide

Scan QR-code for more info

CoolSiC™ MOSFETs 750V Generation 2

https://www.infineon.com/applications/automotive/electric-drivetrain/ev-power-conversion

Table of contents

Infineon – One-stop-shop for OBC / DC-DC applications

Power

OBC PFC Stage

OBC DC/DC Stage

HV-LV DCDC Stage

HV

Discretes

- CoolMOS™ CFD7A 650 V
- CoolSiC™ 750 V
- CoolSiC™ 1200 V
- TRENCHSTOP™ IGBT (650 V /1200 V)
- CoolGaN™ *(650 V)*


CoolSiC™ D2PAK-7


CoolSiC™ QDPAK


CoolSiC™ TO247-4

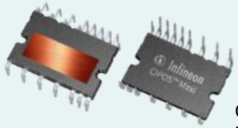
Integrated solution

- Easy Modules


CoolSiC™ Easy 1B package

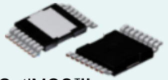

CoolSiC™ Easy 2B package

- IPM *(coming soon)*


CIPOS™ Maxi

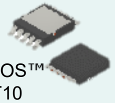
LV

- OptiMOS™ 40V or above

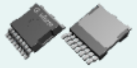

OptiMOS™ TOLT


OptiMOS™ TOLL


OptiMOS™ SSO8


OptiMOS™ SSOT10


OptiMOS™ sTOLL


OptiMOS™ TOLG

Gate Driving and Sensing

Gate Drivers & Dig. Isolators

Sensors

GD

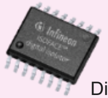
- EiceDRIVER™
- Isolated Gate driver (1-ch, 2ch)


2-ch isolated gate driver


1-ch isolated gate driver

Isolators

› ISOFACE™ Digital Isolator


Digital isolator

Current

- XENSIV™ current sensor


TISON package


DSO-300mil package

Control & Supply

MCU

PMIC

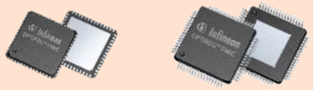
AURIX

- AURIX™ TC3x MCU
- AURIX™ TC4x MCU (new)


TC4x MCU

PMIC

- OPTIREG™ PMIC


OPTIREG™ PMIC

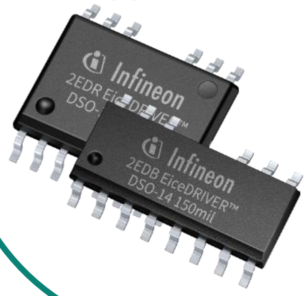
QDPAK TSC + EiceDRIVER™ delivers optimized cost and performance for Automotive OBC & HV-LV DCDC system designs

QDPAK TSC

	SoP date
650 V CoolMOS™ CFD7A & S7A(T)	RELEASED
750 V CoolSiC™	RELEASED
1200 V CoolSiC™ G1p	RELEASED

+

EiceDRIVER™



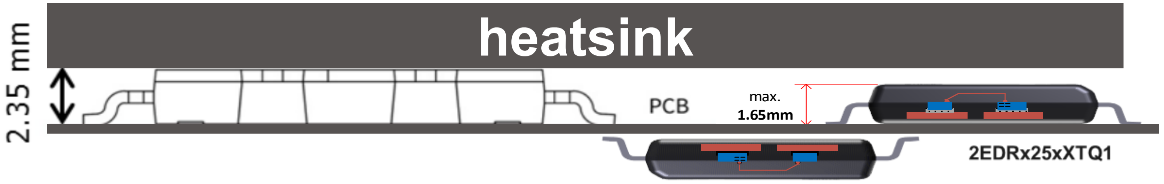
	SoP date
2EDRx25xXQ1	RELEASED
2EDRx25xXTQ1	RELEASED
2EDBx259TQ1	RELEASED

**From SOP date the Salescodes are orderable. Leadtime have then to be taken into account*

Unipolar Gate-Driving compatibility, delivers optimal $R_{DS(on)}$ performance on the switches

Package CTI* >600V from **EiceDRIVER™** eases system certification and compliance

Narrow height of gate driver makes it a perfect companion to QDPAK TSC, even under the heatsink



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