

CoolSiC™ MOSFETs 1200 V G2 in D²PAK-7 package

Infineon Technologies AG

September 2024

restricted

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Striving for excellence in SiC MOSFETs by trench technology



CoolSiC™ Generation 1

- Established the benchmark in efficient power conversion
- Solved the gate oxide reliability risk in SiC MOSFETs using a trench gate
- Overcame common SiC MOSFET limitations in control and drive
- Made all industry-standard packages available

Reliable performance

CoolSiC™ Generation 2

- Securing a **price-performance leap**
- Maintaining G1 **high reliability**
- Adding new **robustness features for** maximizing each $ invested in SiC-based power systems
- Advancing the **packaging technology** for more powerful products

Unmatched industry leadership

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SiC MOSFETs 1200 V - Support of several application trends by significant advantages over silicon-based solutions

Increasing power for **reducing charging time**



Smaller, lighter and more powerful inverters with ever **increasing Watt/kg**



Cutting energy losses in 24/7 operation





Fan less drive in industrial automation



Compact integration of inverter and motor



Cutting losses for **extra energy** from the battery

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CoolSiC™ MOSFET 1200 V G2 by D²PAK-7 introduction

CoolSiC™ G1	CoolSiC™ G2 wave 1	CoolSiC™ G2 coming soon in 2024-2025

1200V



TO-247-4
10 products
7mΩ - 350 mΩ



TO-247-3
10 products
7mΩ - 350 mΩ



D²PAK-7
7 products
30 mΩ - 350 mΩ



D²PAK-7
12 products
8 mΩ - 234 mΩ



TO-247-4
9 products
7 mΩ - 78 mΩ



QDPAK Half-bridge
4 products
12 mΩ - 53 mΩ



QDPAK
10 products
4 mΩ - 78 mΩ

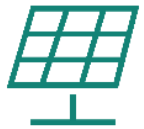
TSC= Top Side Cooling

Best in class R_{DSon}

G2 $R_{DS(on)}$ [mΩ]	D²PAK-7 (TO-263-7) Generation 2	Potential application power
8	**IMBG120R008M2H**	50kW+
12	**IMBG120R012M2H**	
17	IMBG120R017M2H	
22	IMBG120R022M2H	
26	IMBG120R026M2H	
34	IMBG120R034M2H	
40	IMBG120R040M2H	
53	IMBG120R053M2H	
78	IMBG120R078M2H	
116	IMBG120R116M2H	
181	IMBG120R181M2H	~100W
234	IMBG120R234M2H	



EV charging



Solar



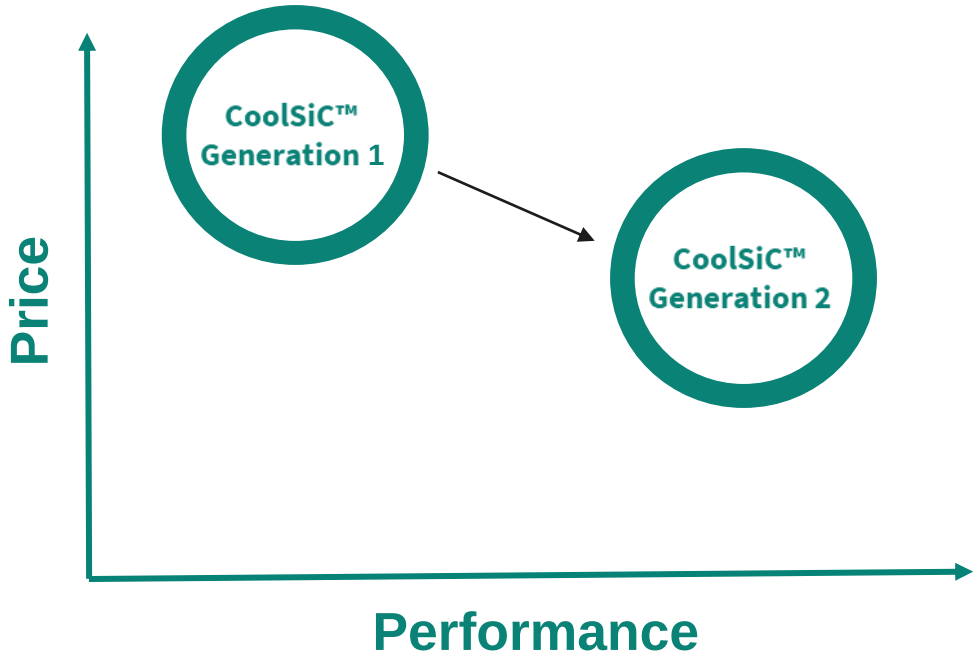
UPS



Drives

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CoolSiC™ MOSFET G2: higher system performance per $ or € invested in SiC



Advantages

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



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CoolSiC™ MOSFETs now even better: G2 comparison over G1



CoolSiC™ Generation 2

Improved chip performance	5~20% lower power losses over typical load use cases
Improved .XT package interconnect	12% better thermal resistance, $R_{th,j-c}$
Best-in-class $R_{DS(on)}$ and the most granular portfolio in the market	8 mΩ in G2 compared to 30 mΩ in G1, 12 products enable the optimal product choice
Overload operation up to Tvj = 200°C and avalanche robustness	**New in G2!**
Maximum $R_{DS(on)}$ at high temperature specified in datasheet	**New in G2!**
Robust **short-circuit** rating	2 µs
Enlarged maximum gate-source voltage	-10 V to +25 V
High reliability	Maintaining G1 proven level, very low DPM rates

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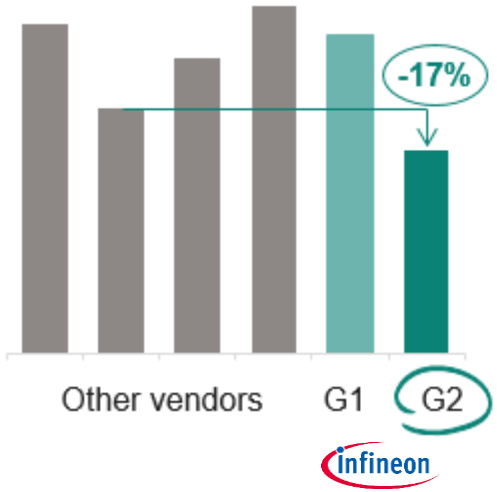
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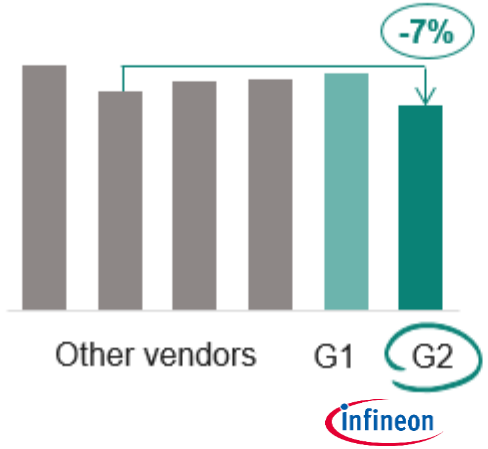
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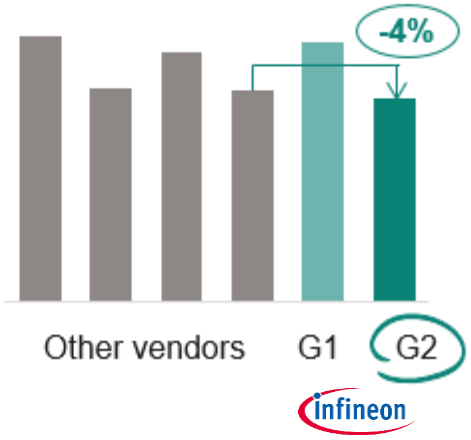
Unveiling a new performance budget with CoolSiC™ G2

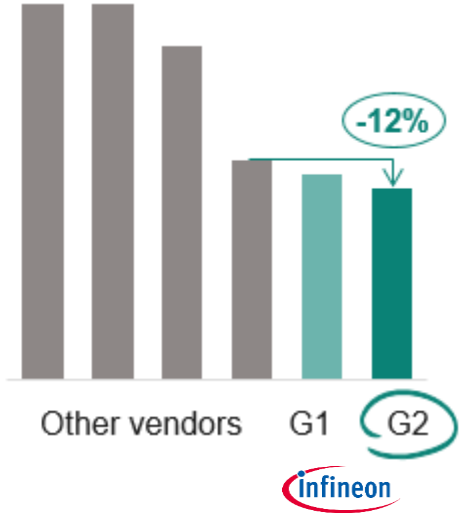
Figures-of-merit (FOM) comparison: lower is better for energy efficiency optimization

R_{DSON} x Q_{GD} (mΩ*µC) at 150°C, 800 V, 28 A:	R_{DSON} x Q_{OSS} (mΩ*µC) at 150°C, 800 V:	R_{DSON} x E_{OSS}(mΩ*µJ) at 150°C, 800 V:	The classical MOSFET FOM (from low-voltage silicon world) R_{DS} x Q_G (mΩ*µC) at 150°C:
Lower is better in hard-switching topologies	Lower is better in soft-switching topologies	Lower is better for light-load efficiency	Lower means lower gate driving power loss







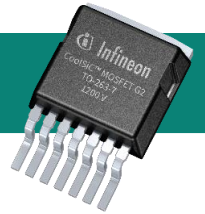


Infineon products: IMBG120R030M1H, IMBG120R026M2H.
Other SiC MOSFETs: value of parameters taken from datasheet in internet for the latest generations of 1200 V SiC MOSFETs in D2PAK 7pin: C3M0032120J1, SCT4018KW7, NTBG030N120M3S, SCT025H120G3AG,
Q_{GD} = total charge associated to C_{RSS} at given conditions, Qoss= total charge associated to C_{OSS} at given conditions. E_{OSS} = total energy associated to C_{OSS} at given conditions

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

Hard-switching



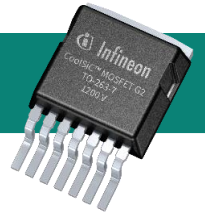


Application conditions with G1 (IMBG120R030M1H) and G2 (IMBG120R026M2H):
DC-AC inverter or AFE stage. I_{RMS} = 20 A, f_{sw} = 40 kHz, R_G = 10 Ω, Tj= 100°C. dead time = 200ns

Total power loss reduction for better energy efficiency and cooling optimization

Soft switching

with LLC or CLLC topology



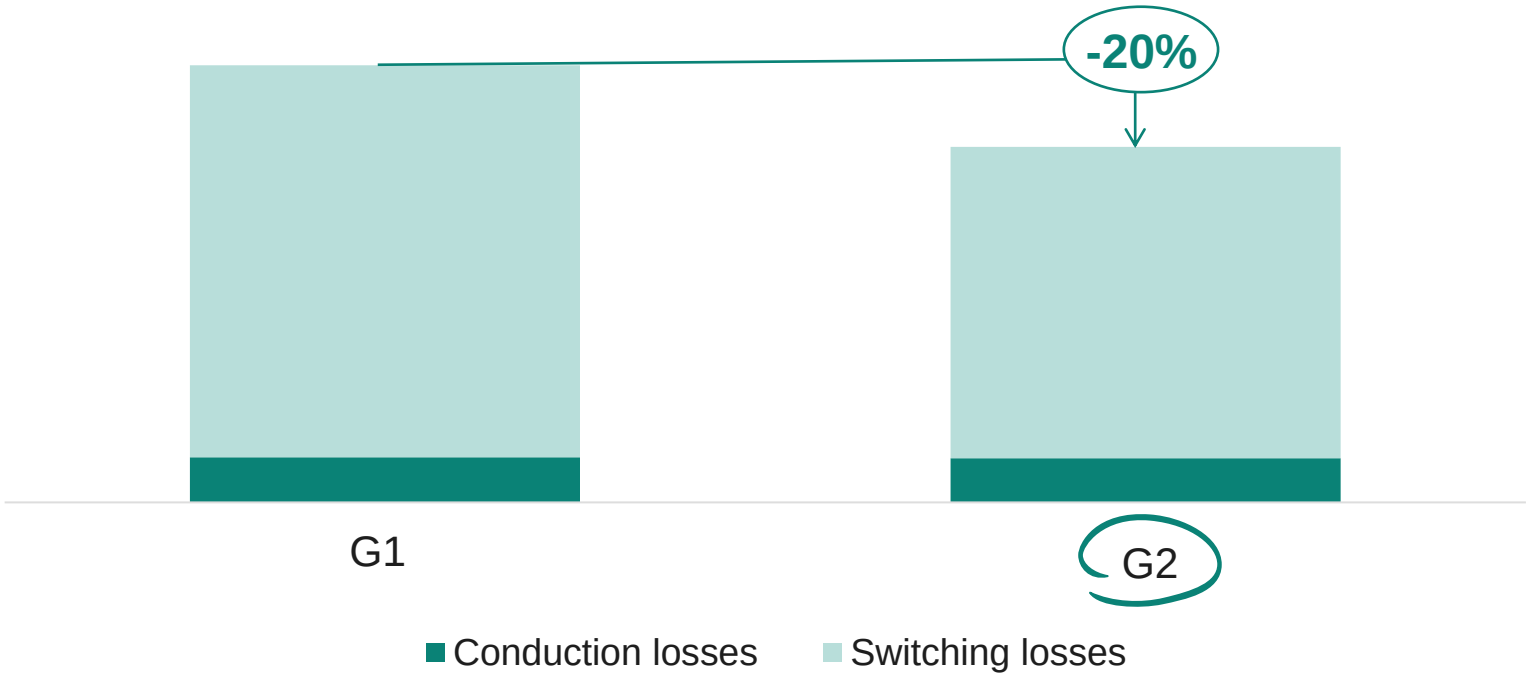


Application conditions with G1 (IMBG120R030M1H) and G2 (IMBG120R026M2H):
DC-DC stage, I_{RMS} = 20 A, f_{sw} = 100 kHz, R_G = 10 Ω,, Tj= 100°C, dead time = 200 ns, soft-switching operation

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CoolSiC™ G2 in light-load condition: significant improvement of power losses





Total power losses reduced by improved switching performance

Application conditions: DC-AC inverter or AFE stage with G1 (IMBG120R030M1H) and G2 (IMBG120R026M2H). I_{RMS} = 5 A, f_{sw} = 40 kHz, R_G = 10 Ω. Tj= 100°C, dead time = 200ns

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Infineon Generation 2 CoolSiC™ accelerates the reduction of CO2



Charging station equipped with G2 instead of G1: ~10% lower power losses



~900 GWh energy saving every year when charging 100 million cars*



~ 350.000 tons CO_2 reduction**



Without extra energy consumption, additional 300.000 cars can be charged for every 100 million on the streets

****equivalent to a small city of 80 000 houses energy use per year**



*** ~3 MWh/year per eCar assumed, based on: 15000 km/year with an average consumption 20 kWh/100 km**

Assumed average CO_2 emission per kWh grid electricity: 0,39 kg/kWh. Source: www.eia.gov

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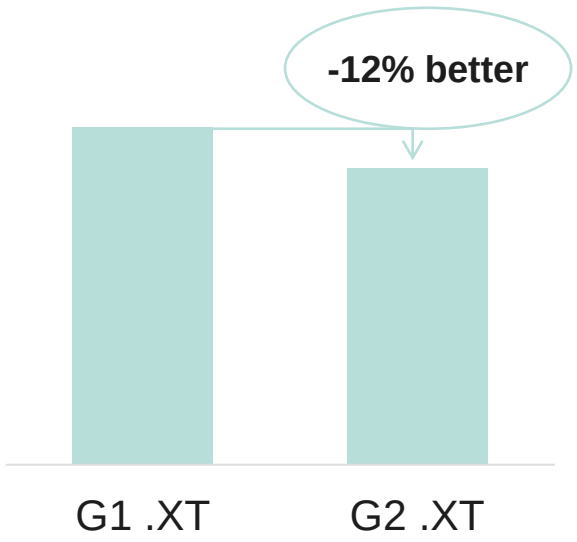
Enhancement of thermal capabilities in small package form factor

- New chip technology means heat concentrated in a smaller area
- Innovative chip technology needs innovative interconnection
- **CoolSiC™ G2 comes with improved .XT technology**

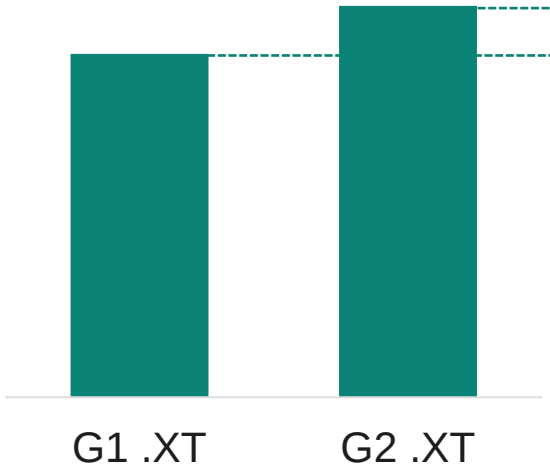


CoolSiC™ .XT

$R_{th,j\text{-}c,max}$ [K/W]



Loss dissipation capability [W]



>14% extra loss can be dissipated

- 6-7% extra current
- ~5 °C lower temperature
- up to 50% increase in f_{sw}

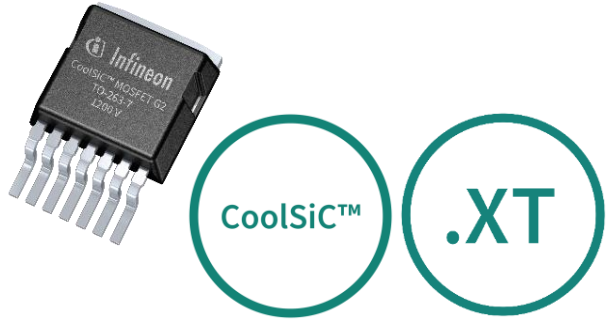
Comparison is made with G1 and G1 products having equal $R_{DS(on)}$ at T_{vj}= 100 °C.

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Raising the bar for the power possible in SMD



- CoolSiC™ G2 trench technology in combination with .XT interconnect enables an **8 mΩ rated 1200V SiC MOSFET in D2PAK-7 package**
- The highest output capability in D2PAK-7 form factor enables higher system power or reduced paralleling of devices



*Status January 2024, based on datasheet comparison 1200 V SiC MOSFETs in the internet: IMBG120R008M2H versus NTBG014N120M3P. Calculation based on conduction losses, ID @ 90°C IMS, Rth_IMS= 1 K/W, 800 V DC bus

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CoolSiC™ MOSFETs 1200 V G2: new and unique robustness features



CoolSiC™ Generation 2

1. Overload operation up to T_{vj} = 200°C and avalanche robustness

For coping with overload events coming from e.g. grid fluctuations, the system designer can now design for higher output currents compared to the previous generation or reduce on cooling efforts. The specified avalanche robustness on datasheet level further eases the system design effort for such over-current events.

New and unique!

2. Maximum $R_{DS(on)}$ at high temperature specified in datasheet

The system designer can now benefit from a datasheet specification of maximum on-resistance at 150°C in G2 portfolios. The SiC MOSFET capability can be fully utilized when no additional margins due to uncertainty of distributions must be accounted for at elevated temperatures during nominal operation.

New & unique!

3. Robust short-circuit rating

The short-circuit capability guaranteed on datasheet level, known from G1 portfolios, is maintained in G2, now at 2 µs.

Pioneer!

4. Enlarged and reliable maximum gate-source voltage

-10 V to +25 V in G2 serves the purpose of all the SiC applications without any compromise in design flexibility. Infineon has pioneered in in application lifetime testing for SiC MOSFETs, and these tests related to gate-source voltage specifications are now included in the JEDEC standard.

Pioneer!

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CoolSiC™ – another great example for Infineon‘s Quality Leadership

dpm – defects per million for GIP SiC products



Data based on G1 SiC power switches sold

- Infineon‘s SiC power switches never caused any „spill“ or severe incident on customer side
- The product returns for SiC are even below silicon-based power switches, a very mature technology
- This counts for discrete devices as well as for power modules
- Infineon‘s CoolSiC™ provides the same or even better quality level as silicon to our customers

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Summary

CoolSiC™ MOSFETs G2 enables the accelerated design of more cost optimized, efficient, compact, and reliable systems, by

- Enabling very low power losses in both, hard-switching and soft-switching topologies
- Improved thermal performance by .XT advancements
- Raising the bar for the power possible in an SMD package
- Adding new robustness features and setting a new standard for utilization of SiC performance
- Making use of trench technology for combining performance with reliability meeting the most stringent requirements

The CoolSiC™ trench MOSFET design drives sustainable competitiveness for energy efficiency, today and in the future!



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Support
Product family name

Marketing material	– Product briefs – Selection guides – Application brochures – Presentations – Press releases, ads
Technical material	– Application notes – Technical articles – Simulation models – Datasheets, MCDS files – PCB design data
Evaluation boards	– Evaluation boards – Demo boards – Reference designs
Videos/ Distribution trainings	– Technical videos – Product information videos

Websites
- Silicon Carbide MOSFET Discretes
- CoolSiC™ G2 landing page
- Product presentation
- Product type pages

Technical material:
- Application note
- Fighting guide

Reference board:
- REF-DR3KIMBGSiC2MA

Videos
- Teaser CoolSiC™ MOSFET G2 in general
- Microlearning CoolSiC™ MOSFET 1200 V G2

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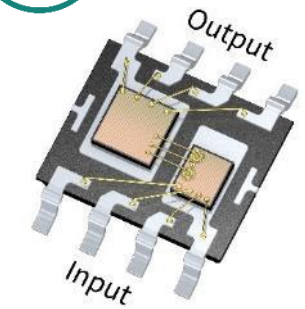
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Every Switch Needs A Driver, the Right Driver Makes a Difference

EiceDRIVER™ isolated gate driver portfolio category

ED-E Enhanced



EiceDRIVER™ Enhanced

Up to 2300 V, 9 A
DESAT, Miller clamp

+ Complementary product:



– **2EP (2EP1xxR):** simplify the design of isolated GD power supply

Rich feature-set for advanced protection:

– **X3 Digital (1ED38xx):** I2C configurable enabling predictive maintenance
– **X3 Analog (1ED34xx):** Best-in-class DESAT accuracy, Analog Configurability
– **F3 (1ED332x):** Cost effective solution with DESAT





www.infineon.com/gdenhanced

ED-C Compact

EiceDRIVER™ Compact

Up to 2300 V, 18 A
Miller clamp, 2-level slew-rate-control

Reduced feature-set and easy to design-in:

– **2L-SRC Compact (1ED32xx):** EMI & switching loss optimization
– **X3 Compact (1ED312x):** easy to design
– **X3 Compact Gen 2 (1ED314x & 2ED314x):** simple and cost effective





Recently Released products with Reinforced isolation (UL 1577 and VDE-11)
New and Upcoming products

www.infineon.com/gdcompact

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EiceDRIVER™ Isolated Gate Driver ICs for CoolSiC™ MOSFET

2300 V functional isolation, UL 1577 and VDE 0884-11 certified

2ED3142MC12H (NEW)



EiceDRIVER™ X3 Compact:

2-ch gate driver with Deadtime Control

- Output current: 6.5 A
- CMTI: 200 V/ns
- Output supply voltage: 35 V
- $UVLO_{on}$: 14 V
- Prop. Delay(accuracy): 50 ns (8 ns)
- Package: DSO14 300 mil

1ED3142MC12H (ES now, MP Q3C24)

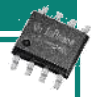


EiceDRIVER™ X3 Compact:

1-ch gate driver with Split Output

- Output current: 6.5 A
- CMTI: 200 V/ns
- Output supply voltage: 35 V
- $UVLO_{on}$: 14 V
- Prop. Delay(accuracy): 45 ns (7 ns)
- Package: DSO8 300 mil

1ED3142MU12F / 1ED3127MU12F



EiceDRIVER™ X3 Compact:

1-ch gate driver with Split Output / Miller Clamp

- Output current: 6.5 A / 10 A
- CMTI: 300 V/ns / 200 V/ns
- Output supply voltage: 35 V / 40 V
- $UVLO_{on}$: 14 V
- Prop. Delay(accuracy): 45 ns(7 ns) / 90 ns(7 ns)
- Package: DSO8 150 mil

1ED3321MC12N



EiceDRIVER™ F3 Enhanced:

1-ch gate driver with DESAT & Miller Clamp

- Output current: 8.5 A
- CMTI: 300 V/ns
- Output supply voltage: 40 V
- $UVLO_{on}$: 12 V
- Prop. Delay(accuracy): 80 ns(15 ns)
- Package: DSO16 300 mil

1ED3491MC12M / 1ED3890MC12M



EiceDRIVER™ X3 Analog / Digital:

1-ch gate driver with DESAT & Miller Clamp and Analog / Digital (I^2C) configurability including ADC

- Output current: 11 A
- CMTI: 200 V/ns
- Output supply voltage: 40 V
- $UVLO_{on}$: 12.5 V / Adjustable
- Prop. Delay(accuracy): 236 ns(30 ns)
- Package: DSO16 fine pitch 300 mil

2EP130R (ES now, release 2024-09)



EiceDRIVER™ Power:

Full-bridge transformer-driver for isolated gate driver power supply

- Duty cycle, adjustable: 10%..50%
- Frequency, adjustable: 50 kHz..695 kHz
- OCP, adjustable: 60 mA..650 mA
- Input supply range: 4.5 V to 20 V
- Max. output power: 10 W
- Package: TSSOP-8

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