



Littelfuse SiC Solution lineup

March 2024

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Business Development and Technical Sales
Semiconductor Business Unit (SBU)



Expertise Applied | Answers Delivered

Rebooting Littelfuse SiC portfolio

- **~50 new part numbers planned rollout to Q2'2025**

- state of the art chip technology
- SiC MOSFETs and SiC Schottky diodes for industrial applications

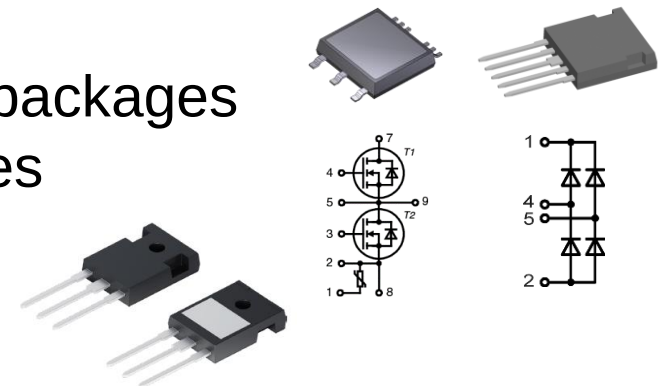
- **Commodity line**

- Standard discrete devices in common TH/SMT packages
- Cost optimized

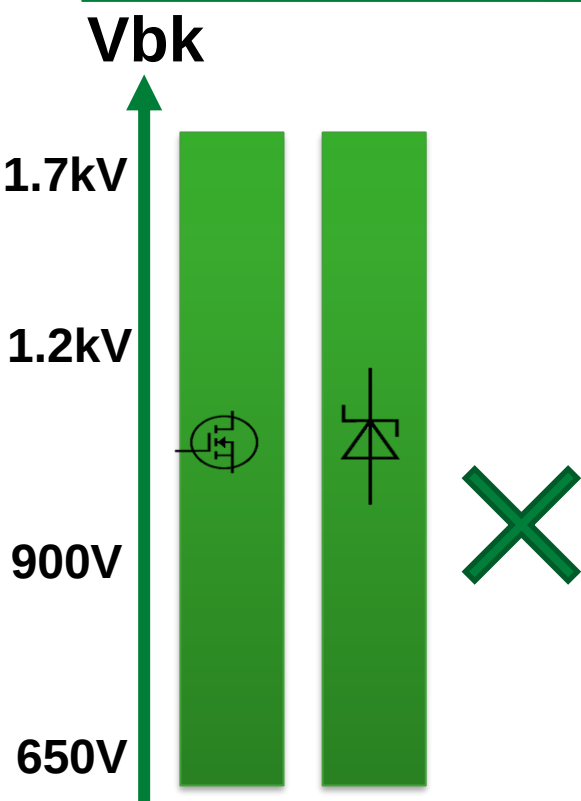


- **Performance / differentiated line**

- Littelfuse value added from isolated & multichip discrete packages
- Modular design with the convenience of discrete packages
- High integration / thermal performance / built-in isolation



A wide range of package x chip combinations



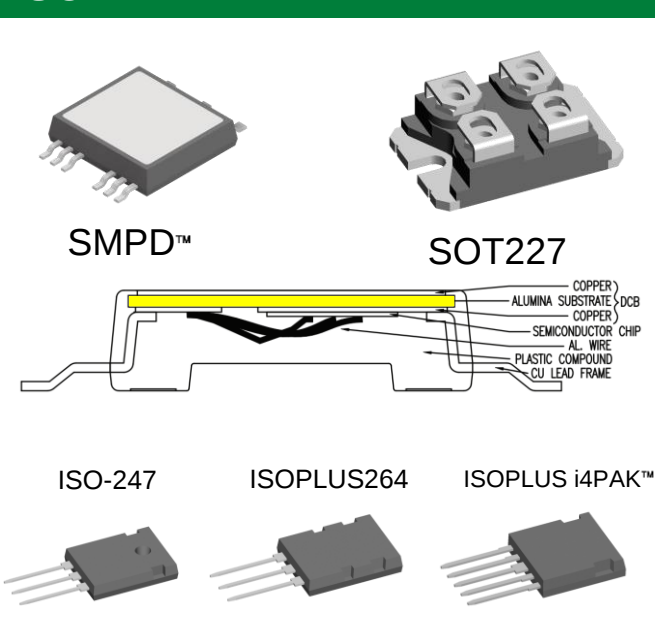
MOSFETs

900 V	1200 V						1700 V
10 mΩ	18 mΩ	30 mΩ	36 mΩ	62 mΩ	80 mΩ	160 mΩ	750mΩ

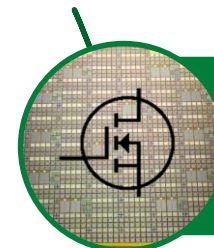
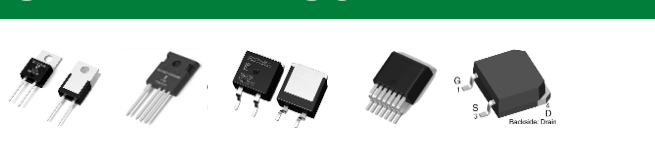
Diodes

650 V	1200 V					1700 V	
10 A	20 A	10 A	15 A	20 A	10 A	25 A	50 A

ISOLATED

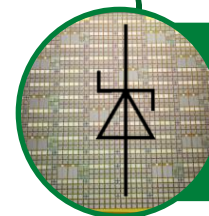
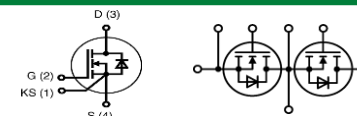


STANDARD DISCRETE



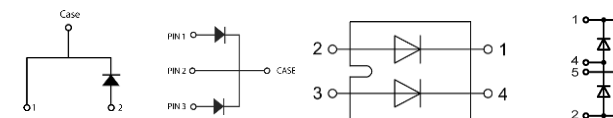
SiC MOSFETs 650V~1.7kV

18mΩ ~ 750mΩ



SiC Schottky diodes 650V~1.7kV

10A~40A & 2x20A~2x60A



Wide range of packages, standard and isolated



Commodity line

State of the art standard discrete devices

650V~1200V SiC MOSFETs – commodity line

- **Advanced Planar gate SiC MOSFET**
 - Ron.A 3.2~3.5mΩ.cm³
 - 15~18V gate control
- **Competitive LT**
- **Cross reference list available**
- **Samples and data sheets available**

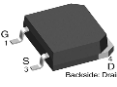
Orderable	R&D Q1 25	R&D Q2 24
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V _{DSS} (V)	R _{DS(on)} (mΩ)	I _D @ 25°C (A)	TO247-4L HV (w/ Kelvin source) 	TO263-7L (D ² PAK) (w/ Kelvin source) 	TOLL 
650	25	100	IXSH100N65L2KHV	IXSA100N65L2-7	IXSG110N65L2K
	40	60	IXSH60N65L2KHV	IXSA60N65L2-7	IXSG60N65L2K
	60	40	IXSH40N65L2KHV	IXSA40N65L2-7	IXSG40N65L2K
1200	13.5	150	IXSH150N120L2KHV		
	30	79	IXSH80N120L2KHV	IXSA80N120L2-7	
	40	65	IXSH65N120L2KHV	IXSA65N120L2-7	
	80	40	IXSH40N120L2KHV	IXSA40N120L2-7	
	160	20	IXSH20N120L2KHV	IXSA20N120L2-7	

Non released devices' schedule and characteristics subject to change without notice

High voltage SiC MOSFETs

- For auxiliary power supply
- TO268HV-2L package with high clearance for polluted environment

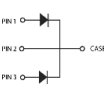
					Released	R&D	NRND
V_{DSS} (V)	$R_{DS(on)}$ (m Ω)	TO247-3L 	TO263-7L (D ² PAK) (w/ Kelvin source) 	TO268HV-2L (D ³ PAK) 			
1700	750	LSIC1MO170E750	LSIC1MO170T0750-TU LSIC1MO170T0750-TR	LSIC1MO170H0750-TU LSIC1MO170H0750-TR			

650~1700V SiC Schottky diodes –commodity line

- SiC Schottky diodes 10A ~ 40A
- State of the art price and lead time
- Cross reference list

Orderable

Q1 25

V_{RMM} (V)	I_F (A) Single/Multiple	Single diode 				Common cathode 	
		TO252-2L  (DPAK)	TO263-2L  (D ² PAK)	TO220-2L 	TO247-2L 	TO263-2L  (D ² PAK)	TO247-3L 
600/650	10		LSIC2SD065D10A	DCK10I650PA	DCK10I650HA		
	20/2*10		LSIC2SD065D20A		DCK20I650HA		DCK20C650HB
	2*20					LSIC2SD065D40CC	LSIC2SD065E40CCA
1200	10	DCK10I1200UZ	LSIC2SD120D10A	DCK10I1200PA	DCK10I1200HA		
	15				DCK15I1200HA		
	20 / 2*10		LSIC2SD120D20A		DCK20I1200HA		DCK20C1200HB
			DCK20I1200PC				
	30 / 2*15				DCK30I1200HA		DCK30C1200HB
	40 / 2*20				DCK40I1200HA		DCK40C1200HB
1700	10				LSIC2SD170B10		
	25				LSIC2SD170B25		

Non released devices' schedule and characteristics subject to change without notice





Performance line

Isolated packages & multichip

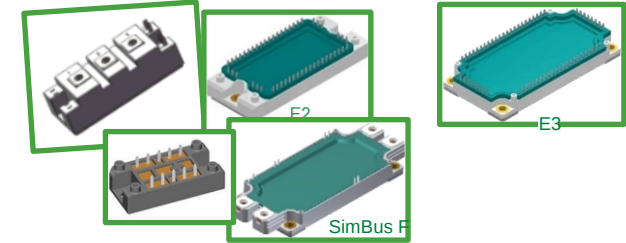
Bridge the gap between standard discrete and modules

Power
density

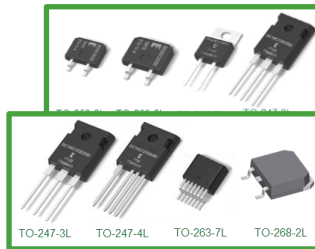
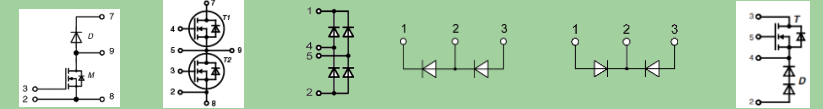
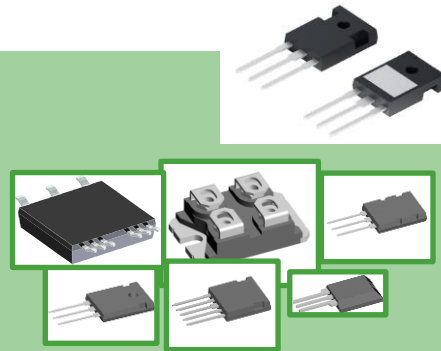


- Littelfuse advanced packages technology
- Close to module performance

- High power, high performance
- Project/customer specific
- Big footprint, thick package
- Complicated handling
- Complete topology

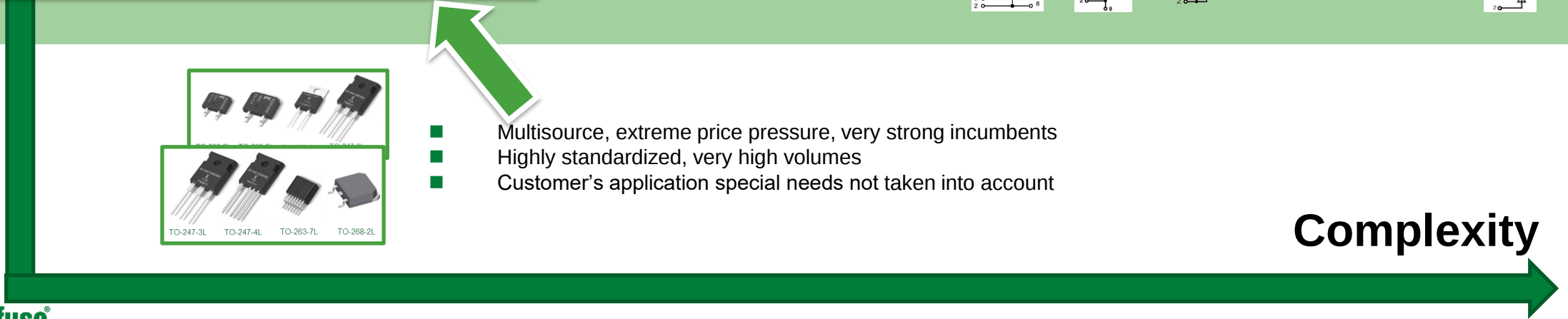


- simpler manufacturing
- Standard building bricks



- Multisource, extreme price pressure, very strong incumbents
- Highly standardized, very high volumes
- Customer's application special needs not taken into account

Complexity



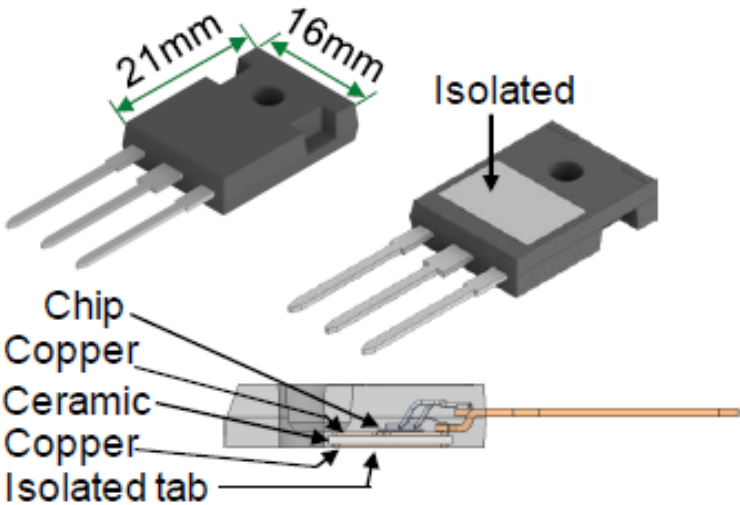
1200V SiC MOSFETs ISO247 new lineup

Non released devices' schedule and characteristics subject to change without notice

- **State of the art trench SiC MOSFET**
 - Industry leading $R_{on,A} < 3\text{m}\Omega.\text{cm}^3$
 - Industry leading parasitics
- **-4V~+18V gate**
 - 0V gate switching
- **Advanced ceramic package**
 - AMB substrate
 - 2.5kV isolation
- **High power industrial power supplies**
 - Can replace equivalent standard TO247 parts
 - Reduced component count
 - System level added value vs. standard discrete devices
 - Interesting for application with high level of paralleling

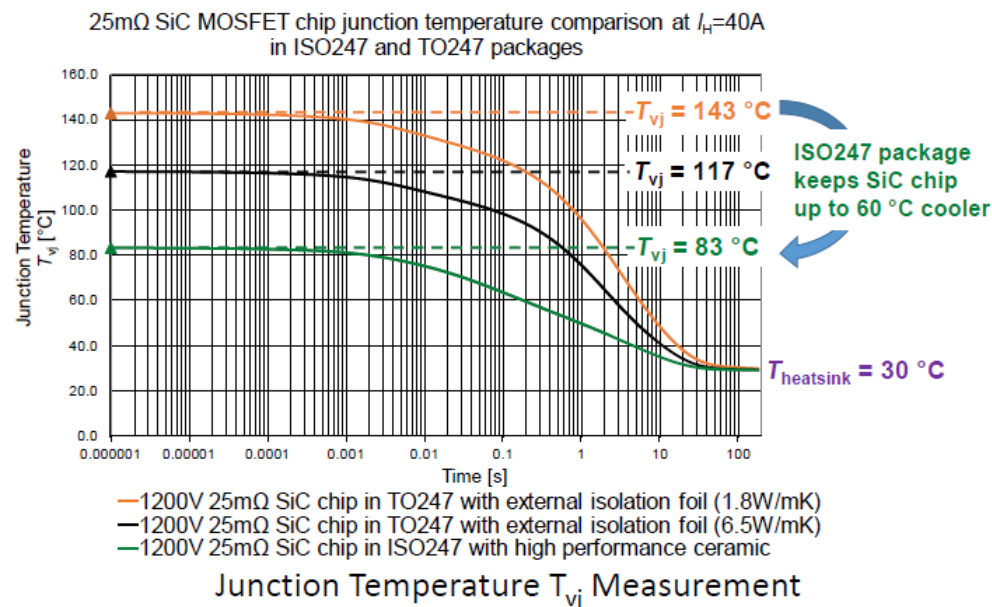
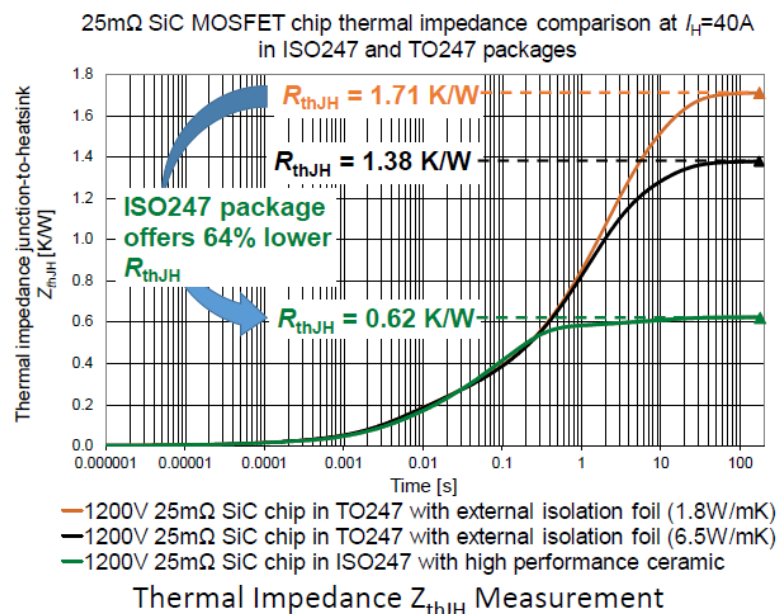
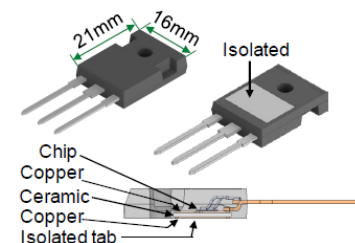
orderable	R&D Q1 25
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V_{DSS} (V)	$R_{DS(on)}$ (m Ω)	I_D @ 25°C (A)	ISO247-3L (2500V~ isolation)	ISO247-4L (2500V~ isolation w/ Kelvin source)
1200	18	80	IXSJ80N120R1	IXSJ80N120R1K
	36	43	IXSJ43N120R1	IXSJ43N120R1K
	62	25	IXSJ25N120R1	IXSJ25N120R1K



Thermal Performance Advantages: ISO247 vs. Standard discrete

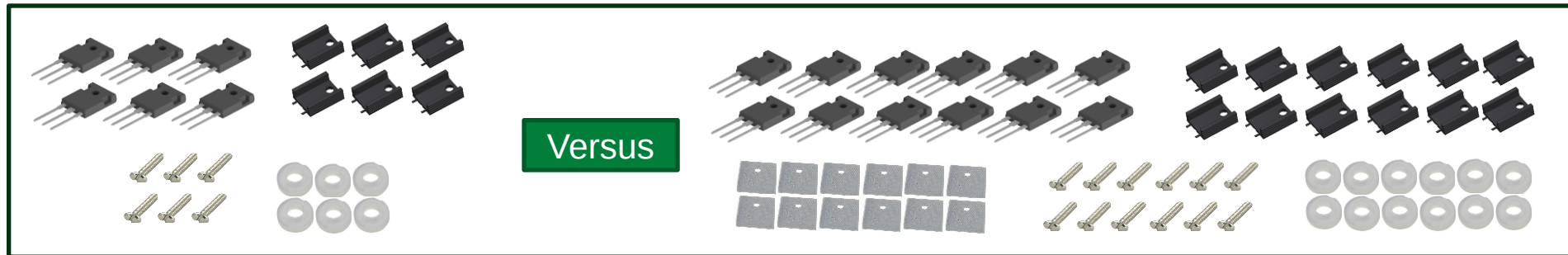
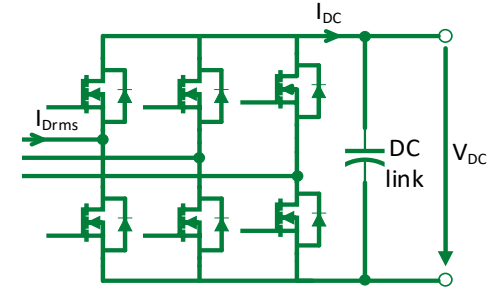
- IXSJ MOSFET series, 1200V 18/36/65mΩ MOSFET in ISO247-3 and -4, release from Q4'24
- For industrial power supplies, designs with large number of paralleled devices
- Compared with a non isolated TO247 package, Littelfuse isolated packages offer
 - Up to 64% reduction in R_{thJH} , 60°C lower T_{vj} , 50% more P_{out} at 20kW, T_{vj} 130°C
 - Measured with 1200V, 25mΩ SiC MOSFET, $I_H=40A$, according to IEC 60747-8



System Level Cost Saving Opportunity: ISO247 vs. TO247

Example 22 kW active front end converter for a DC charger

- Significant system level cost savings achieved from:
 - Lower component count, reduced space and size on the PCB.
 - Improved yield and quality by eliminating the external isolation foil



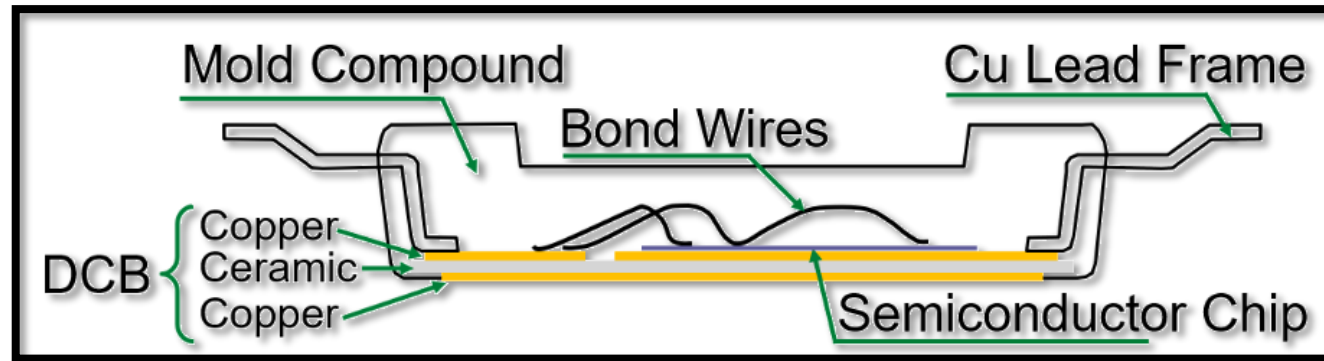
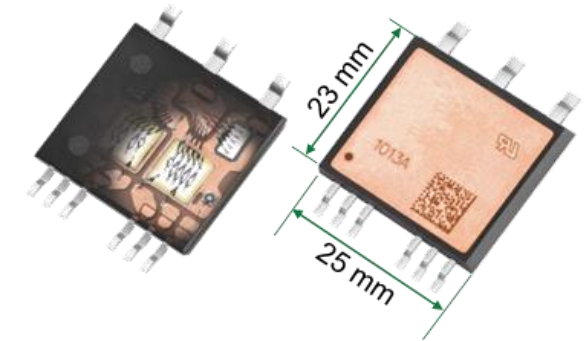
	ISO247-4	TO247-4
Total number of device	6	12
No. of isolation pad	No need	12
Mounting efforts	Simplified	12 screw, washer, heat-sink, man power, tooling
Minimum required PCB area	2500 mm ²	5000 mm ²

ISOPLUS™ SMPD – since 2012

Bridging the gap between modules and discrete

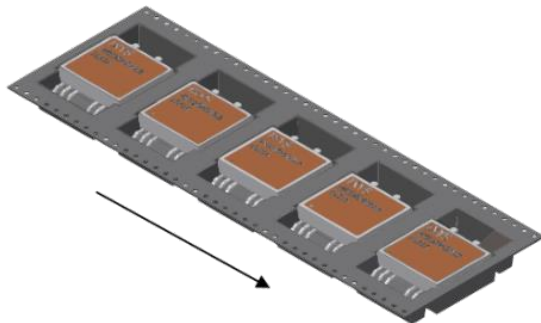
■ “Surface Mount Power Device”

- Top side cooled isolated package using **D**irect **C**opper **B**onded (DCB) or **A**ctive **M**etal **B**razed (AMB) substrates

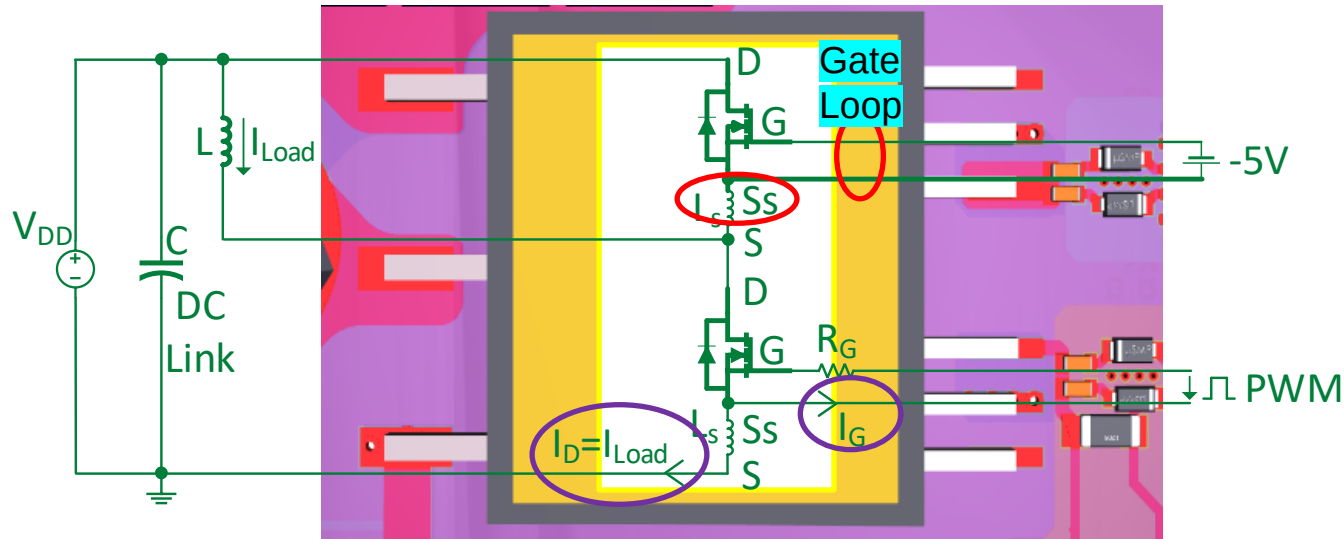


■ Key features & benefits

- Pick and place compatible, simplified mounting and production
- Top side cooling
- Top side electrically isolated, from 2.5kV_{rms} (UL rated)
- 35% to 50% reduction of junction-heatsink R_{th} vs. non isolated packages, superior system-level thermal performance
- Shortened power loop, lower component count



ISOPLUS™ SMPD – improvements by integration



- Gate drive path is separated from load circuit thanks to kelvin source.

Better gate control

- Common source inductance L_s is excluded from gate loop

Faster switching
Reduced gate oscillations

- No negative feedback of load current into the gate loop

Improved EMI
Less risk of parasitic turn-on

- Minimized mutual parasitic inductance and coupling capacitance

Improved EMI

- Minimized losses

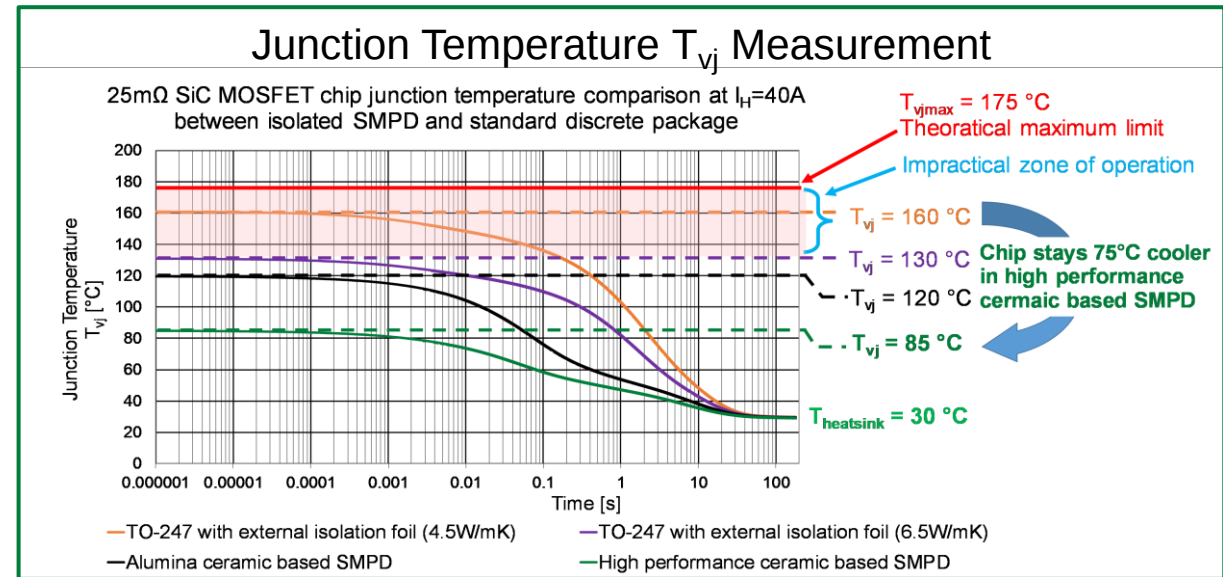
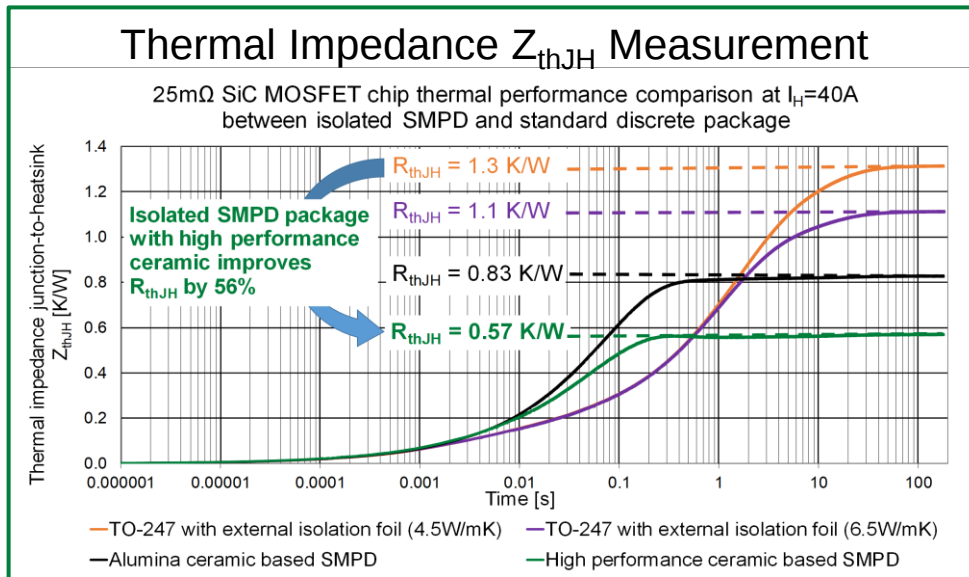
Improved efficiency
Lower T_{vj} , simplified thermal design

Thermal Performance Advantages: SMPD vs. TO247

Compared with a non isolated TO247 package, the SMPD offers

- At same drain current*
- With Al_2O_3 ceramic: a chip 40°C cooler, 36% reduction in thermal resistance R_{thJH} , 30% reduction in ΔT_{JH}
- With Si_3N_4 ceramic: a chip 75°C cooler, 56% reduction in thermal resistance R_{thJH} , 58% reduction in ΔT_{JH}

*measured with 1200V, 25mΩ SiC MOSFET, $I_H=40\text{A}$, according to IEC 60747-8

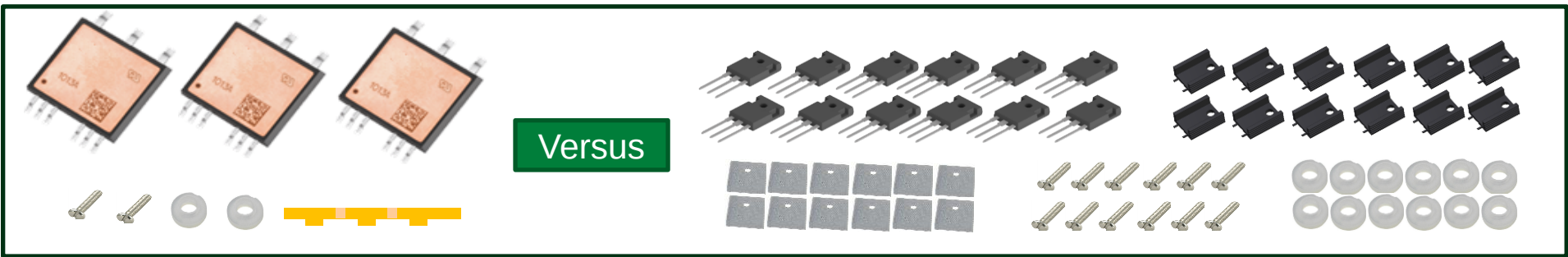
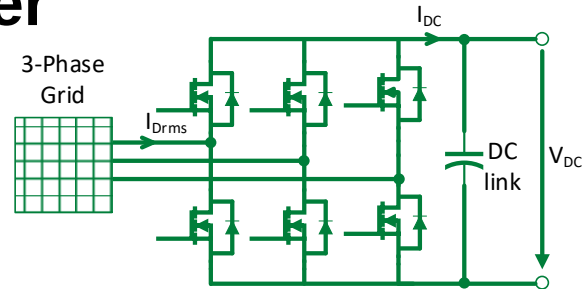


PCIM 2023, Littelfuse poster

System Level Cost Saving Opportunity: SMPD vs. TO247

Example 22 kW active front end converter for a DC charger

- Significant system level cost savings achieved from:
 - Lower component count, reduced space and size on the PCB.
 - Pick & place manufacturing
 - Improved yield and quality by eliminating the external isolation foil

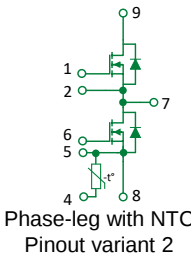
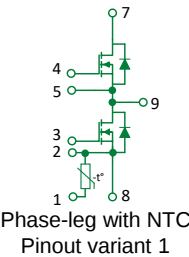
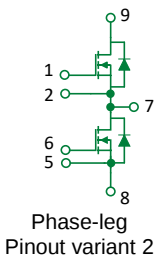
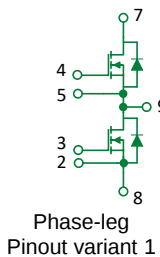


	SMPD	TO-247
Total number of device	3	12
No. of isolation pad	No need	12
Mounting efforts	Simplified	12 screw, washer, heat-sink, man power, tooling
Minimum required PCB area	2400 mm ²	5000 mm ²

SiC MOSFETs Half Bridges in SMPD: 1200V

Non released devices' schedule and characteristics subject to change without notice

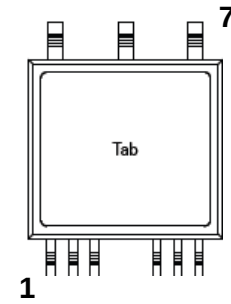
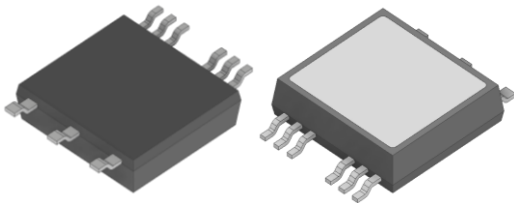
- State of the art trench SiC MOSFETs in SMPD package
- Lower thermal resistance, higher power dissipation and cooler chip compared to discretes
- Available in two different pin-out and integrated temperature sensing



Released

Q2 25

V _{DSS} (V)	R _{DS(ON)} (mΩ) @ 25°C	I _D (A) @ 25°C	Phase-leg		Phase-leg with NTC	
			SMPD-B Pinout variant 1	SMPD-B Pinout variant 2	SMPD-B Pinout variant 1	SMPD-B Pinout variant 2
1200	18	80	MCR60P1200	MCR59P1200LB ●	MCR60P1200TLB ●	MCR59P1200TLB ●
	25	55	MCB40P1200LB ●			
	36	43	MCR30P1200LB ●	MCR29P1200LB ●	MCR30P1200TLB ●	MCR29P1200TLB ●
	40	38	MCB30P1200LB ●			
	62	25	MCR20P1200LB ●	MCR19P1200LB ●	MCR20P1200TLB ●	MCR19P1200TLB ●
	80	25	MCB20P1200LB ●			
	160	19.5	MCL10P1200LB ●			



● High performance ceramic

● Standard ceramic



Comprehensive lineup / roadmap

650V~1200V SiC MOSFETs new lineup

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Released

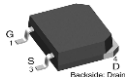
R&D
Next sample / Release

NRND

V _{DSS} (V)	R _{DS(on)} (mΩ)	I _D @ 25°C (A)	ISO247-3L (2500V~ isolation) 	ISO247-4L (2500V~ isolation w/ Kelvin source) 	TO247-4L (w/ Kelvin source) 	TO263-7L (D ² PAK) (w/ Kelvin source) 	TOLL 	SOT-227 (2500V~ isolation, w/ Kelvin source) 
650	25	100			IXSH100N65L2KHV Mar 25/Apr 25	IXSA110N65L2-7TR Mar 25/Apr 25	IXSG110N65L2K Mar 25/Apr 25	
	40	60			IXSH60N65L2KHV Mar 25/Apr 25	IXSA60N65L2-7TR Mar 25/Apr 25	IXSG60N65L2K Mar 25/Apr 25	
	60	40			IXSH40N65L2KHV May 25/Apr 25	IXSA40N65L2-7TR May 25/Apr 25	IXSG40N65L2K May 25/Apr 25	
900	10	130						IXFN130N90SK
1200	13.5	150			IXSH150N120L2KHV June 25			
	18	80	IXSJ80N120R1 Now / Mar'25	IXSJ80N120R1K Jan'25				
	21	75						IXFN75N120SK
	30	79			IXSH80N120L2KHV	IXSA80N120L2-7TR		
	32	55						IXFN55N120SK
	36	43	IXSJ43N120R1	IXSJ43N120R1K Q4'24 / Jan'25				
	40	65			IXSH65N120L2KHV Mar 25 / Apr 25	IXSA65N120L2-7TR Mar 25 / Apr 25		
	62	25	IXSJ25N120R1 Now / Mar'25	IXSJ25N120R1K Q4'24				
	75	30						IXFN30N120SK Now/Mar'25
	80	40			IXSH40N120L2KHV	IXSA40N120L2-7TR		
	160	20			IXSH20N120L2KHV April 25	IXSA20N120L2-7TR April 25		

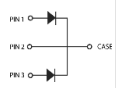
High voltage SiC MOSFETs

- For auxiliary power supply
- TO268HV-2L package with high clearance for polluted environment

		Released R&D Release NRND		
V_{DSS} (V)	$R_{DS(on)}$ (mΩ)	TO247-3L 	TO263-7L (D ² PAK) (w/ Kelvin source) 	TO268HV-2L (D ³ PAK) 
1700	750	LSIC1MO170E750	LSIC1MO170T0750-TU LSIC1MO170T0750-TR	LSIC1MO170H0750-TU LSIC1MO170H0750-TR

SiC Schottky diodes – new lineup 650-1200kV

Orderable R&D

V_{RMM} (V)	I_F (A) Single/Multiple	Single diode 				Common cathode 	
		TO252-2L (DPAK) 	TO263-2L (D ² PAK) 	TO220-2L 	TO247-2L 	TO263-2L (D ² PAK) 	TO247-3L 
600/650	10		LSIC2SD065D10A	DCK10I650PA	DCK10I650HA		
	20/2*10		LSIC2SD065D20A		DCK20I650HA		DCK20C650HB
	2*20					LSIC2SD065D40CC	LSIC2SD065E40CCA
1200	10	DCK10I1200UZ May 25	LSIC2SD120D10A	DCK10I1200PA	DCK10I1200HA		
	15				DCK15I1200HA		
	20 / 2*10		LSIC2SD120D20A		DCK20I1200HA		DCK20C1200HB
			DCK20I1200PC TBC				
	30 / 2*15				DCK30I1200HA		DCK30C1200HB
	40 / 2*20				DCK40I1200HA		DCK40C1200HB

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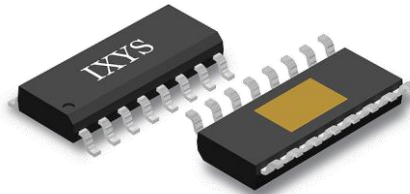
			Prod	R&D ENG/Release	Idea	NRND
V _{RMM} (V)	I _F (A)	1PH rectifier bridge			Dual	
		ISOPLUS SMPD-B 	ISOPLUS I4-PAC 	SOT227 	SOT227 	
	2*60				DCL120X650NA Now / Q1'25	
1200	10		DCL15B1200FC Now / Q2'25			
	20	DCL30B1200LB Now / Q2'25				
	2*20				LSIC2SD120N40PA /	
	50			DCG80B1200NA / DCG81B1200NA		
	2*40				LSIC2SD120N80PA /	
	2*60				LSIC2SD120N120PA /	
	2*100				DCG200X1200NA	



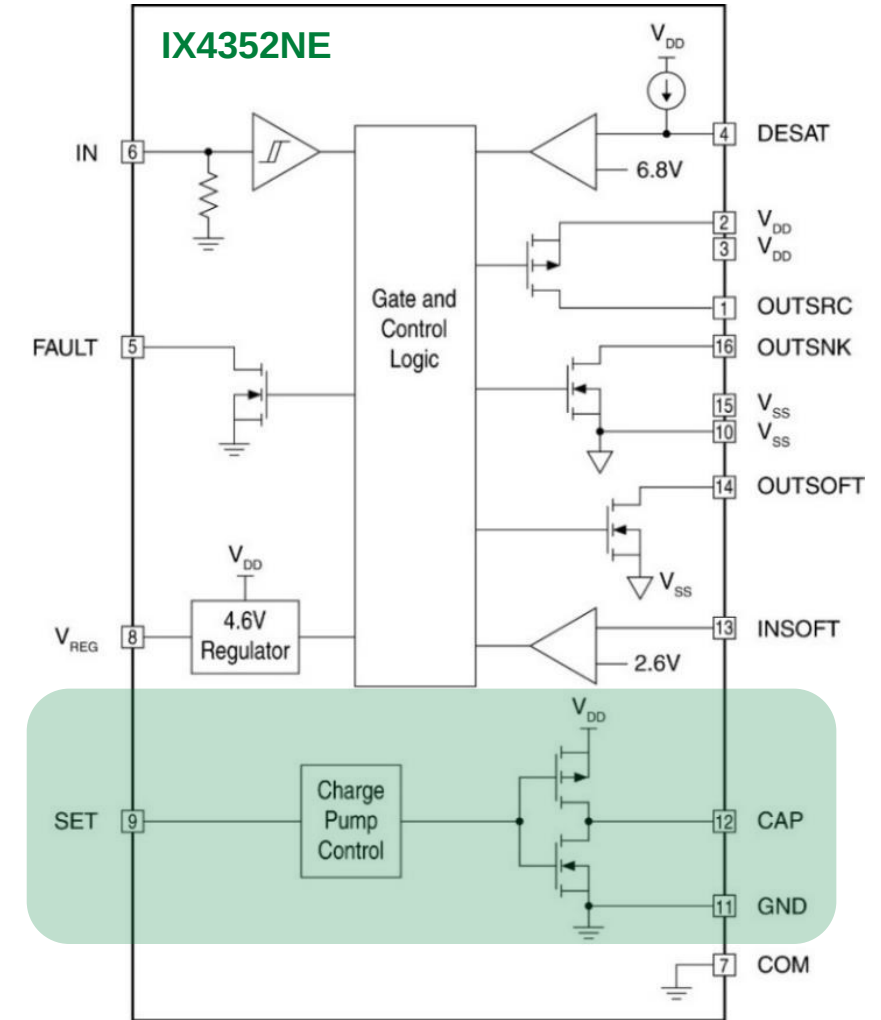
Related products

IX4352NE Driver for SiC-MOSFET

- Unique **9A** sink/source low-side driver for **SiC-MOSFETs** and **high power IGBTs**
- **+25V / -10V** Adjustable Output Gate Drive Voltage Range
- Simplify System Design
 - Programmable **Charge Pump** Regulator for **Negative Gate Drive**
 - No need for external negative gate drive supply
 - TTL/CMOS Logic Level Input (referenced to GND)
 - No logic input level shifting needed
- Extensive Protection
 1. **DESAT** — Desaturation Detection
 - Detects over current condition and initiates **Soft Turn-off**
 2. **UVLO** — Undervoltage Lockout
 - Prevent turn-on with insufficient gate voltage
 3. **TSD** — Thermal Shutdown
 - Prevents driver IC overheating
 4. **FAULT** Output
 - Signal fault condition to microcontroller



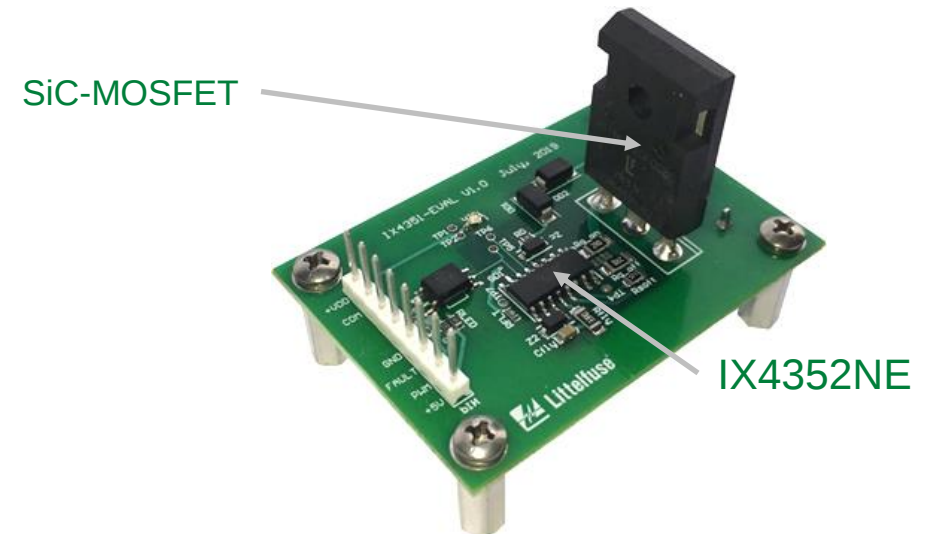
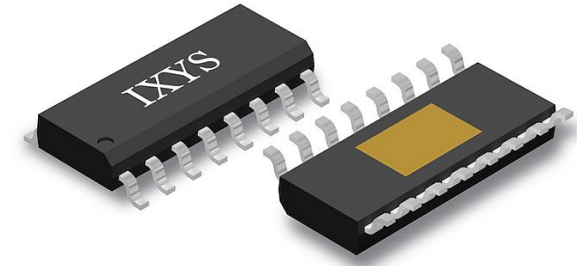
Thermally Enhanced
SO-16 Package



IX4352NE – Low-Side SiC and IGBT Driver (continued)

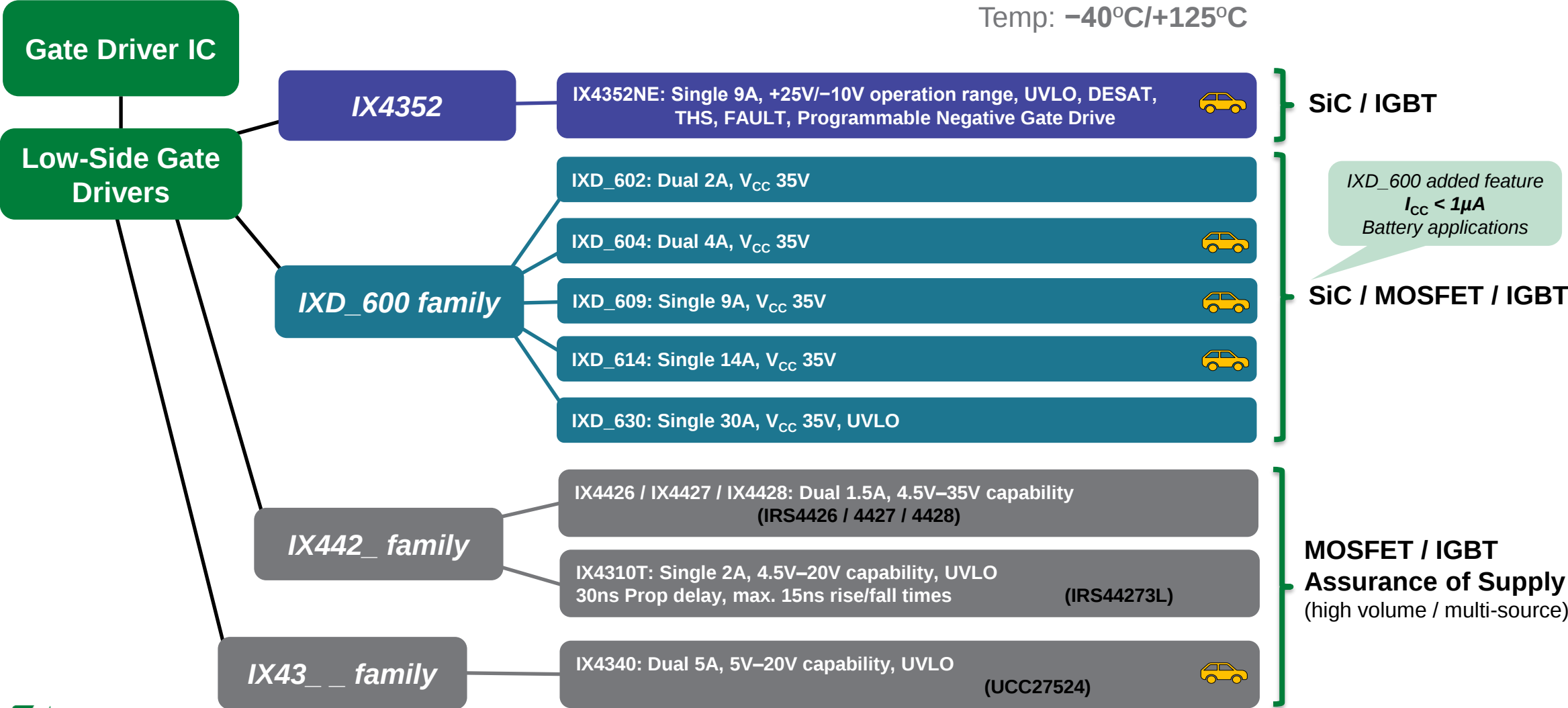
Markets / Applications

- Industrial
 - DC-DC converters
 - Adaptors
 - Battery Chargers
 - including EV/PHEV/FCV on-board and off-board chargers
 - Motor controllers
 - Power inverters
 - including solar inverters



IX4352NE Evaluation Board

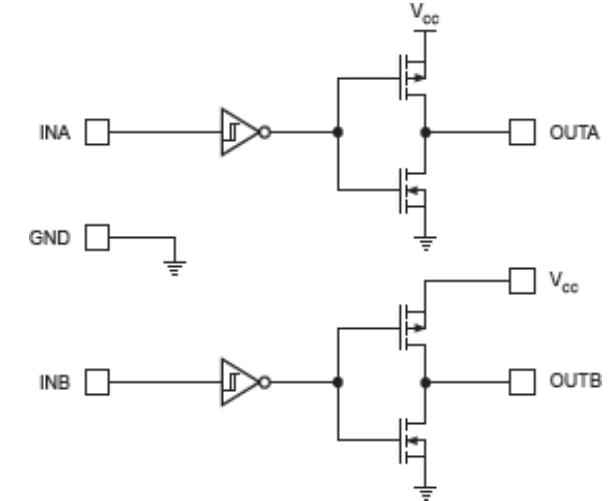
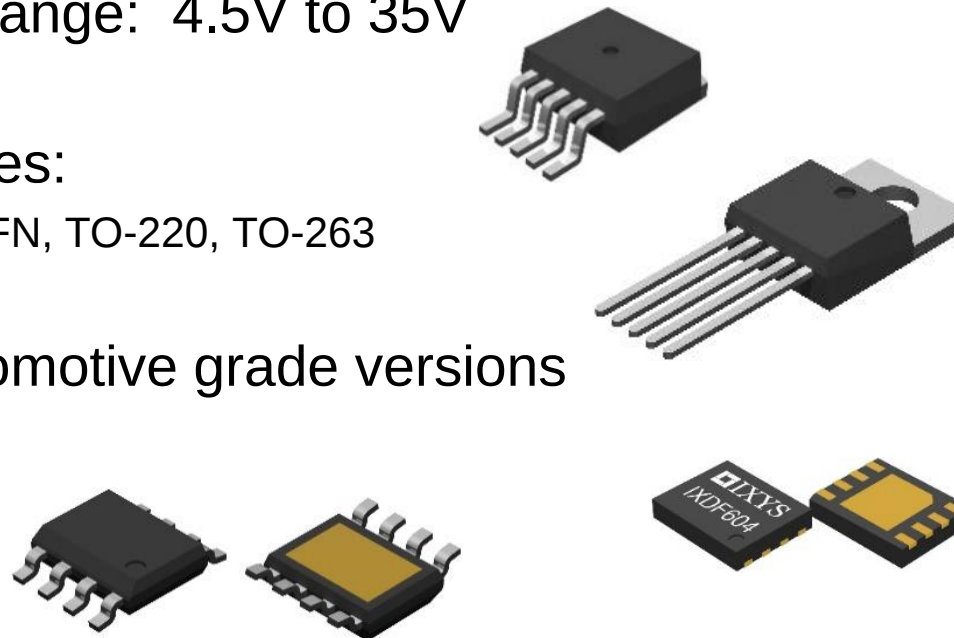
Littelfuse Gate Driver Product Portfolio Summary



IXD_600 Series Low-side Gate Drivers

- 2A – 30A output current capability
 - IXD_602 dual 2A
 - IXD_604 dual 4A
 - IXD_609 single 9A
 - IXD_614 single 14A
 - IXD_630 single 30A
- Wide operating voltage range: 4.5V to 35V
- Wide portfolio of packages:
 - DIP, SOIC, Power SOIC, DFN, TO-220, TO-263
- AEC-Q100 qualified automotive grade versions
 - IXD_604SI dual 4A
 - IXD_609SI single 9A
 - IXD_614SI single 14A

Wolfspeed SiC Gate Driver Boards

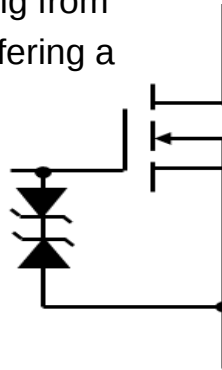


SMFA Series – *Asymmetrical TVS* for SiC MOSFET& IGBT gate protection

Problem/Solution

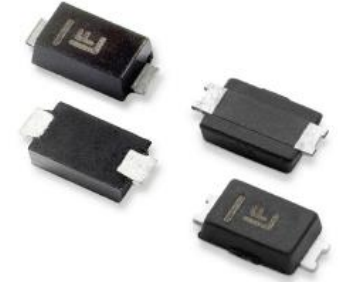
The SMFA Series are Asymmetrical TVS diodes designed specifically to protect SiC MOSFETs gates from overvoltage events. The faster switching speeds of SiC MOSFETs (as compared to Silicon MOSFETs and IGBTs) combined with layout and parasitic elements causes ringing and overshoot phenomena on the gate drive circuit that can be mitigated by the SMFA Series.

As SiC MOSFETs have a different negative gate voltage rating from the positive one, the asymmetrical SMFA Series is ideal in offering a single component solution.



Benefits

- Single component SiC MOSFET gate protection with asymmetrical gate voltage protection
- Compact, 1mm low profile, SOD123-FL package
- Protection against known SiC MOSFET gate reliability issues.



Features

- Low Clamping Voltage for negative gate drive, $V_C < 8\text{ V @ } 2\text{ A (10/1000 }\mu\text{s)}$
- Variety of positive Standoff Voltages, V_{BR} 15 ~ 20 V compatible with popular SiC MOSFETs and IGBT's
- Stable capacitance over wide range of operating frequency (2 MHz) compatible with SiC MOSFET applications

Markets/Applications

- AI/Data center Server Power Supplies
- High Efficiency power for EVI
- High Reliability power supplies for Semiconductor/Industrial equipment



SiC MOSFET Gate Protected by one asymmetric TVS Diode

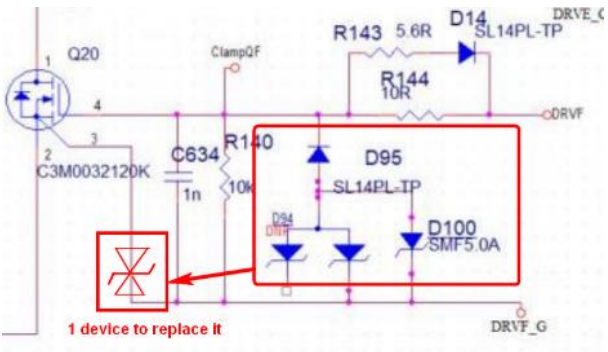


Figure 1. Standard gate protection with two separate TVS diodes vs. one Asymmetric SMFA Series TVS Diode

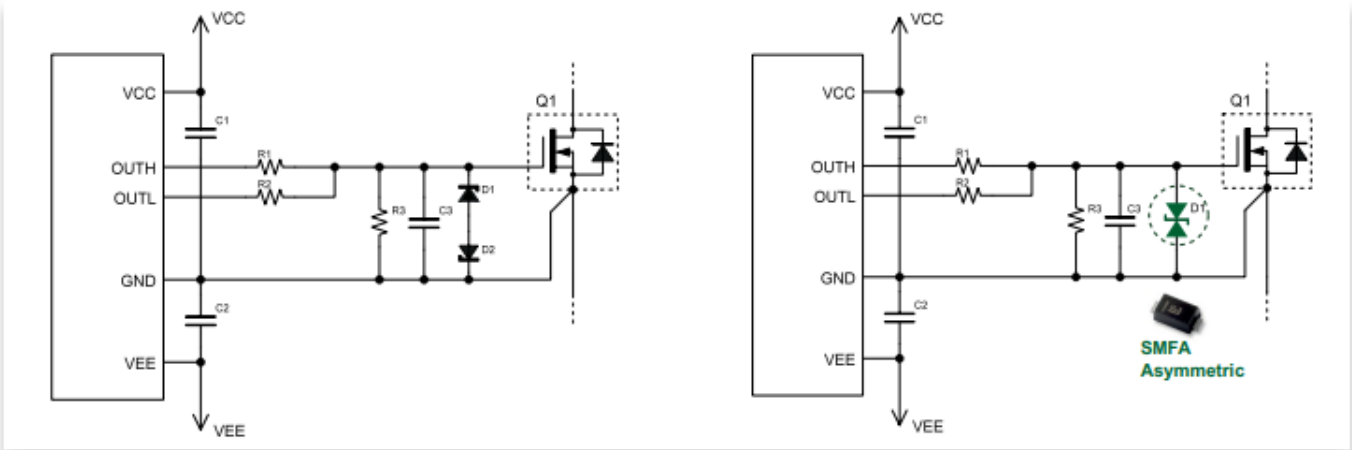
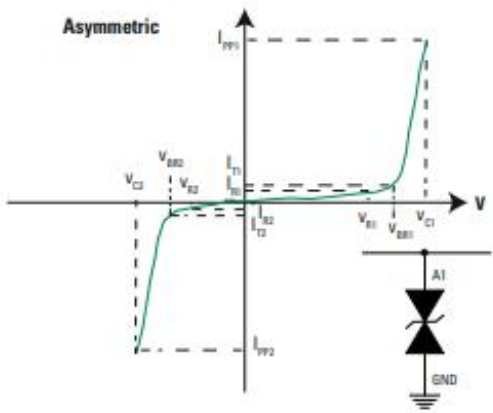
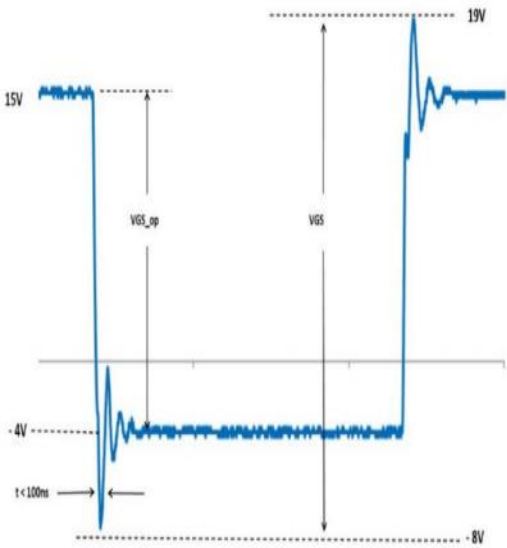
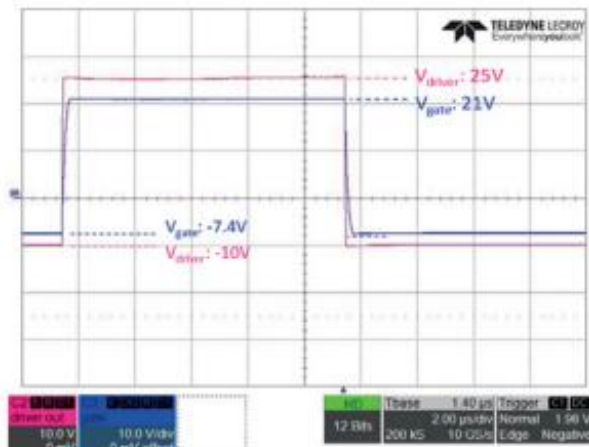


Figure 2. Clamping characteristics of SMFA-type integrated asymmetric TVS Diode



Static characteristics



Dynamic clamping

Local resources supporting our global customers

