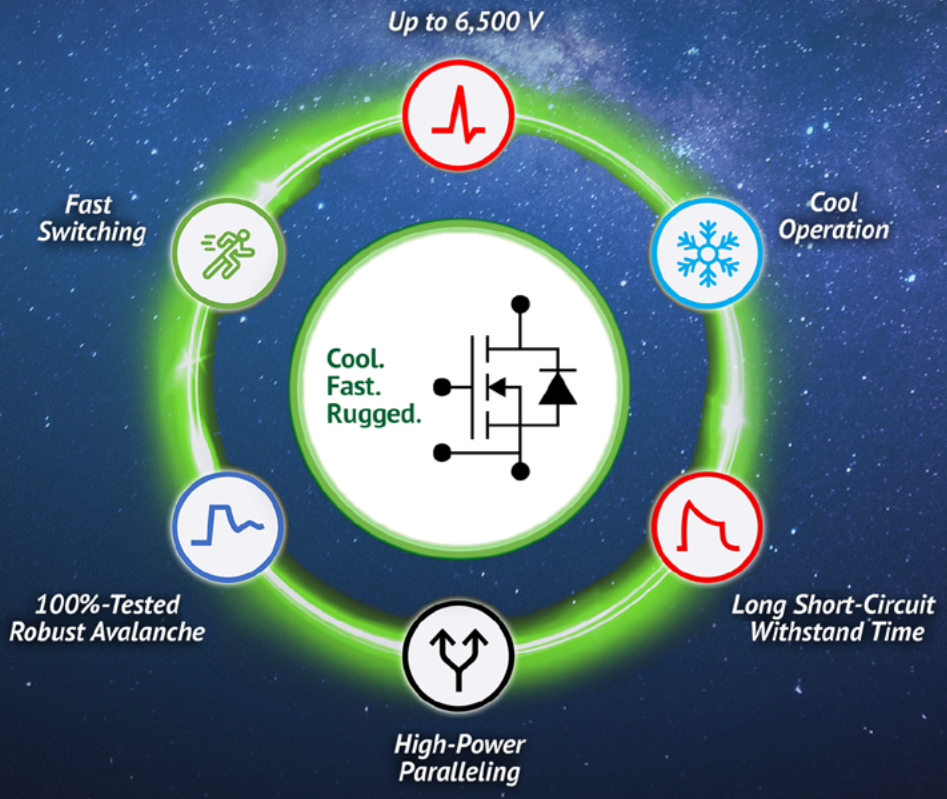
GeneSiC™ Power Devices



Navitas GeneSiC™

Markets and Technology

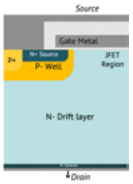
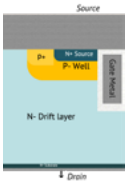
In applications from 20 W to 20 MW, and with device voltages from 650 V to 6.5 kV, GeneSiC silicon carbide (SiC) MOSFETs and Schottky MPS™ diodes drive high-speed, high-efficiency power conversion across diverse markets including EV, industrial automation, solar, wind, grid, motor drives and defense. High-volume, high-quality shipments ensure application performance, reliability and uptime availability.




Trench-assisted planar gate: No-compromise technology

SiC MOSFETs offer superior conductivity and switching performance compared to silicon (Si) due to their 'wide bandgap' characteristics and high electric-field strength. However, traditional designs using legacy planar or trench techniques must compromise between manufacturability, performance, and/or reliability.

GeneSiC's patented trench-assisted planar gate design is a no-compromise, next-generation solution; high-yield manufacturing, fast and cool operation, and extended, long-life reliability.

	Planar	*Trench*	GeneSiC™ *Trench-Assisted Planar*
			
Manufacturability	» *Repeatable* » *High yield* » *Low cost*	» *Inconsistent trench etch* » *Lower yields* » *High cost*	» *Repeatable* » *High yield* » *Low cost*
Performance	» *High $R_{DS(ON)}$ / area* » *Slow switching* » *High $R_{DS(ON)}$ / Δ temp*	» *Lower $R_{DS(ON)}$ / area* » *Faster switching* » *High $R_{DS(ON)}$ / Δ temp*	» *Lower $R_{DS(ON)}$ / area* » *Fastest switching* » *Lowest $R_{DS(ON)}$ / Δ temp*
Reliability	» *Rugged gate oxide (stable V_{TH})*	» *Failures due to non-uniform gate oxide* » *Lower short-circuit capability*	» *Highest 100% tested avalanche* » *Long short-circuit withstand time* » *Rugged gate oxide (stable V_{TH})*

Navitas

Cool. Fast.

GeneSiC™

Efficient, cost-effective power conversion relies on a comprehensive understanding of modern circuit topologies and high-speed (frequency) switching techniques. There are two main device factors;

- *How well does the MOSFET conduct current (measured in $R_{DS(ON)}$)?*
- *How efficiently does the device 'switch' (measured by energy loss, or E_{XX})?*

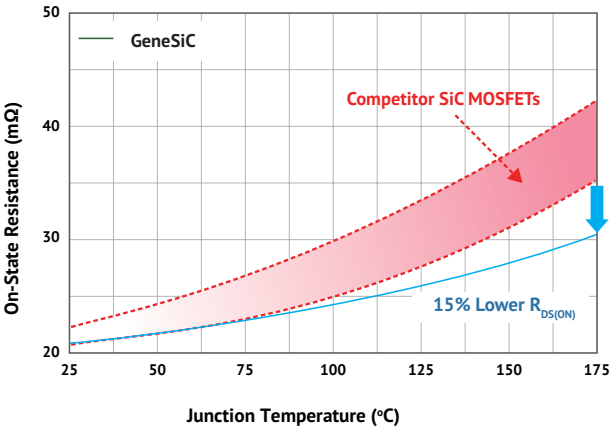
For each question, we must understand the answer in both 'hard-switch' and 'soft-switch' topologies, and under tough high-temperature and high-speed conditions. Combined, a high-temperature, high-speed (frequency) figure-of-merit (FoM) is critical for system performance and reliability.

Supplier	Resistance		Energy Loss		Figure-of-Merit *(Low number is better)*	
	$R_{DS(ON)}$ @ 25°C (mΩ)	$R_{DS(ON)}$ @ 175°C (mΩ)	$E_{ON} + E_{OFF}$ (µJ)	E_{ZVS} (µJ)	Hard-Switching R_{DS} @ 175°C x (E_{ON}+E_{OFF}) (Ω-µJ)	Soft-Switching R_{DS} @ 175°C x E_{ZVS} (Ω-µJ)
GeneSiC™	40	57	680	46	**38.8**	**2.6**
#2	40	68	680	40	46.2	2.7
#3	40	80	1240	355	99.2	28.4
#4	40	71	700	115	49.7	8.2
#5	45	85	585	36	49.7	3.1

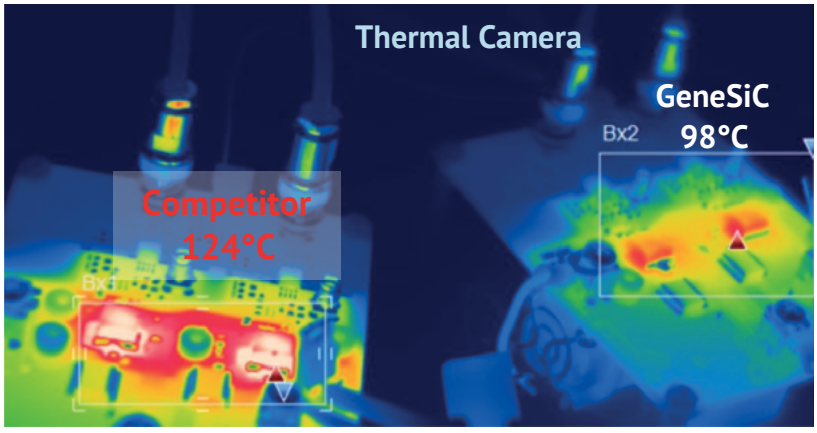
Lowest Power Loss at High Temp, High Speed = ***Highest Efficiency, Energy Savings Small Size, Light Weight, Low System Costs!***

GeneSiC patented trench-assisted planar-gate technology delivers the lowest $R_{DS(ON)}$ at high temperature and the lowest energy losses at high speeds. This enables unprecedented, industry-leading levels of performance, robustness and quality.

$R_{DS(ON)}$ vs T_j



In-circuit, high-speed test



GeneSiC vs. competitor SiC FET

» 1200 V, 20 mΩ, TO-247-4L
» Higher drain current
» Lower conduction losses
» Cooler operation

GeneSiC vs. competitor SiC FET

» 1200 V, 40 mΩ, D2PAK in half-bridge
» 150 kHz switching = ~10x faster than Si IGBT
» 30% lower FET loss vs. other SiC
» 25°C cooler operation = 3x longer lifetime

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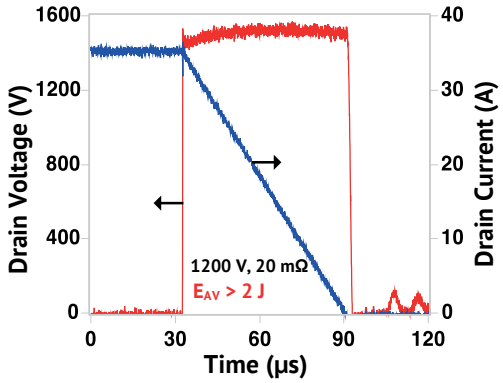
Rugged.

GeneSiC™

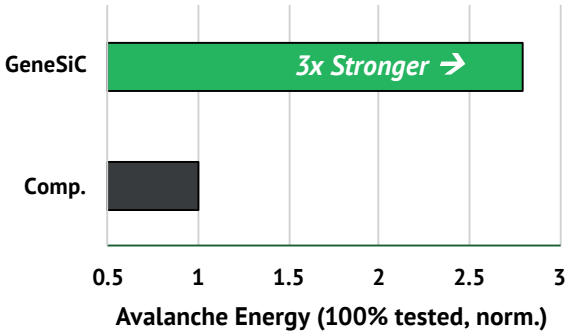
100%-tested avalanche

Highest published capability to handle excess energy in fault condition



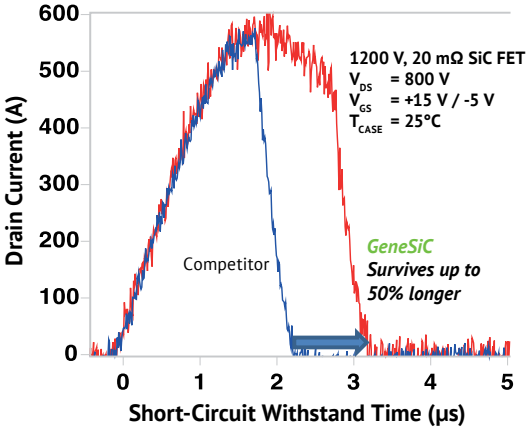
*refer to datasheet for EAS rating

Critical in applications like motor drives to withstand unclamped inductive load (UIL) energy dump in situations like motor open-circuit (O.C.)

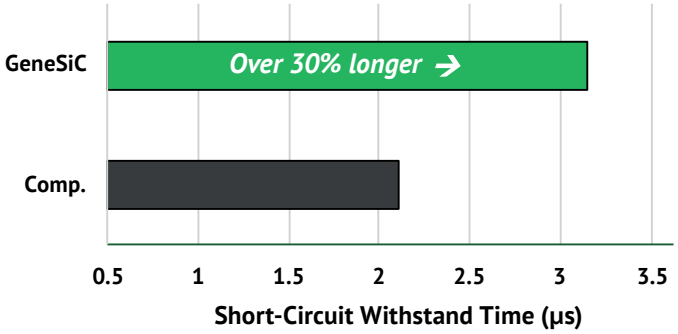


Long short-circuit withstand time

World-class survival duration in fault condition



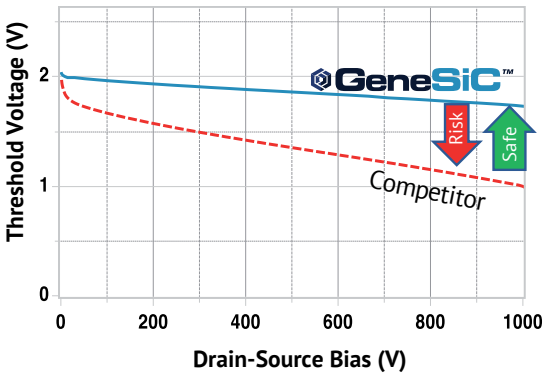
Critical to prevent failures like motor short-circuit where the FET faces full voltage (V_{DD}) in ON-state.



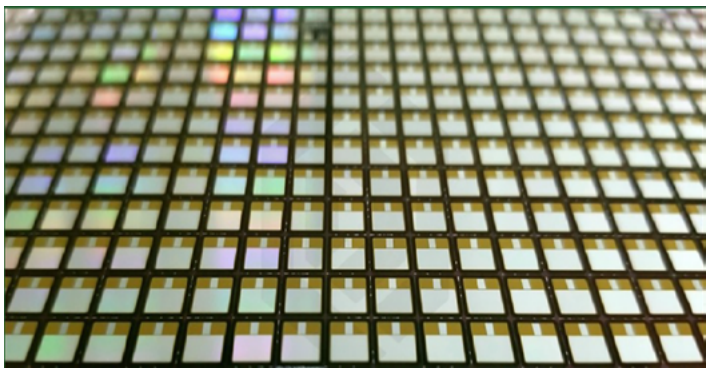
High power paralleling

Matching currents (Stable V_{TH})

Competitor products allow threshold voltage to drop under high-voltage, creating risk of turn-on error



GeneSiC packaged and bare-die FETs can be paralleled reliably for high-power applications



Navitas GeneSiC

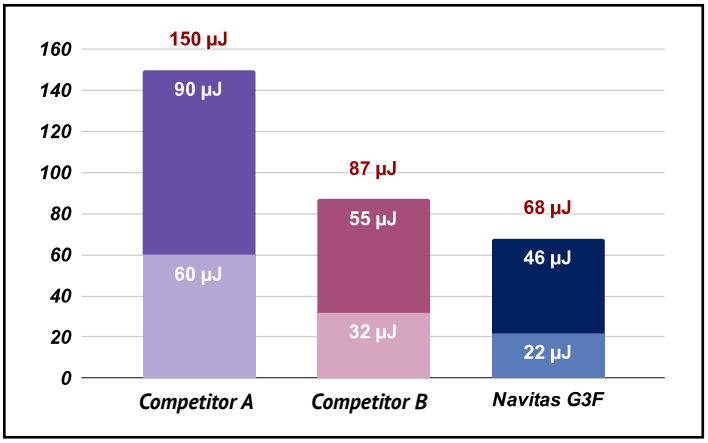
Gen 3 'Fast' SiC MOSFETs

GeneSiC's 3rd generation of fast SiC MOSFETs improves switching performance and system efficiency:

- Optimized EMI
- Low V_F and Q_{RR}
- Robust body diode
- 100% avalanche (UIL) tested
- Ultra-low $R_{DS(ON)}$ vs. temperature dependency

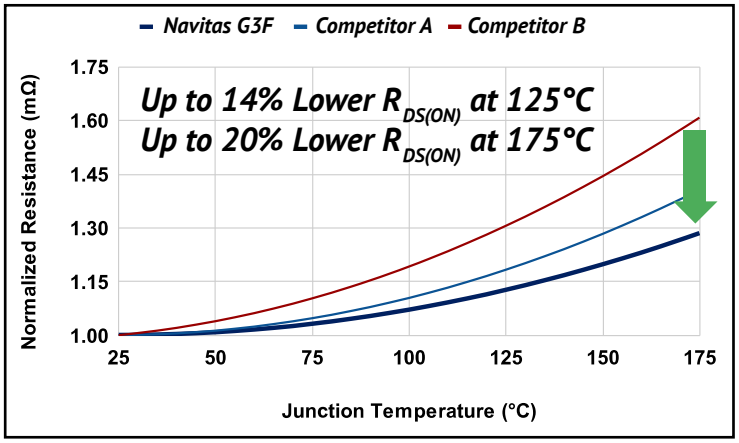
Target applications include EV charging, solar inverters, data center and telecom power supplies, and energy storage systems (ESS).

650V Hard-switching Figure of Merit (E_{ON}, E_{OFF})



Hard-switching E_{ON} & E_{OFF} at VDD = 400V, ID = 35A, T_{amb} = 25°C

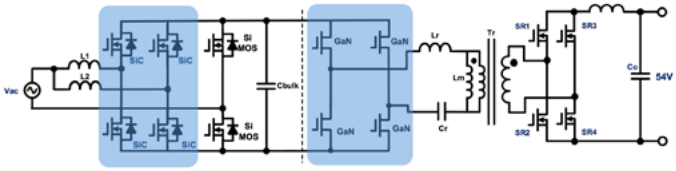
$R_{DS(ON)}$ vs. Temperature (Gen 3F 650V, 20mΩ vs Competition)



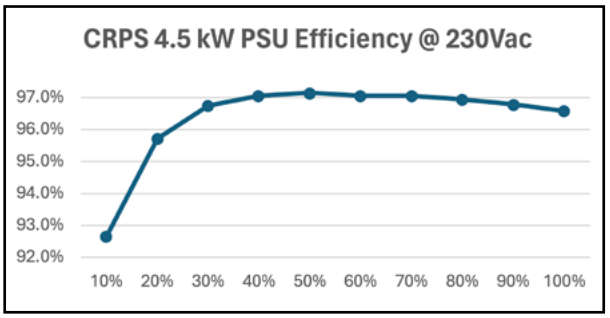
Measured on production parts at I_D = 35A, V_{GS} = 18V

4.5kW, 137W/in³, 97% efficiency AI data center PSU

Gen 3 Fast SiC MOSFET: G3F45MT06L (650V, 40mΩ TOLL)

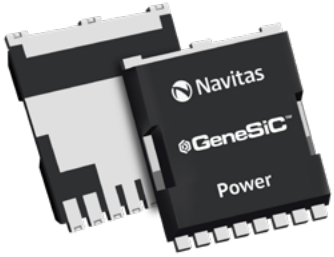


Interleaved CCM TP PFC with G3F SiC MOSFETs & GaNSafe Power ICs



- Up to 137 W/in³ power density
- Exceeds Titanium efficiency (>97%)
- Hold up time: 10ms @4200W
- EMI: Class A with >6dB

TOLL package for high speed, high efficiency, and high-power density systems



- Extremely low package inductance of 2nH
- Small footprint with 30% savings in PCB area compared to D2PAK
- Lower height profile, with 60% lower volume than D2PAK
- Excellent thermal properties, with 9% lower R_{THJC} compared to D2PAK

Navitas GeneSiC™

Widest Range of SiC MOSFETs 650 V - 6.5 kV

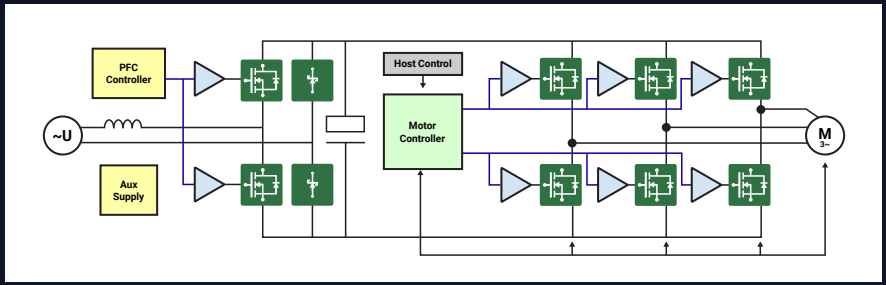
$V_{BR(DSS)}$ (V)	$R_{DS(ON)}$ typ. (mΩ) (@15 V_{GS})	$R_{DS(ON)}$ typ. (mΩ) (@18 V_{GS})	$R_{DS(ON)}$ typ. (mΩ) (@20 V_{GS})	TOLL	TO-263-7 (D2PAK-7L)	TO-247-3	TO-247-4	SOT-227	Die
650		21		*G3F25MT06L*[1]	*G3F25MT06J*[1]		*G3F25MT06K*[1]		*G3F25MT06-CAx*
		29		*G3F33MT06L*[1]	*G3F33MT06J*[1]		*G3F33MT06K*[1]		*G3F33MT06-CAx*
		42		*G3F45MT06L*[1]	*G3F45MT06J*[1]	*G3F45MT06D*[1]	*G3F45MT06K*[1]		*G3F45MT06-CAx*
		55		*G3F60MT06L*[1]	*G3F60MT06J*[1]	*G3F60MT06D*[1]	*G3F60MT06K*[1]		*G3F60MT06-CAx*
1200		18			**G3F18MT12J**[1]		**G3F18MT12K**[1]		**G3F18MT12-CAx**
		20			**G3F20MT12J**[1]		**G3F20MT12K**[1]		**G3F20MT12-CAx**
		25			**G3F25MT12J**[1]		**G3F25MT12K**[1]		**G3F25MT12-CAx**
		34			**G3F34MT12J**[1]		**G3F34MT12K**[1]		
		40			**G3F40MT12J**[1]		**G3F40MT12K**[1]		
		65			**G3F65MT12J**[1]		**G3F65MT12K**[1]		
		75			**G3F75MT12J**[1]		**G3F75MT12K**[1]		
		135			**G3F135MT12J**[1]				
1700	20						**G3R20MT17K**	**G3R20MT17N**	**G3R20MT17-CAx**
	45					**G3R45MT17D**	**G3R45MT17K**		**G3R45MT17-CAx**
	160				**G3R160MT17J**	**G3R160MT17D**			
	450				**G3R450MT17J**	**G3R450MT17D**			
3300			50				**G2R50MT33K**		**G2R50MT33-CAx**
			1000		**G2R1000MT33J**				
6500									*Engineering Samples*

[1] Automotive qualified

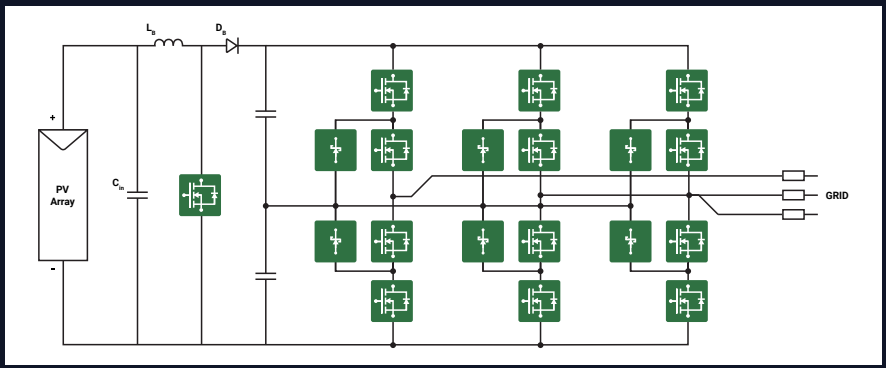
Bare Die Metallization - CAx (-CAL Aluminum, -CAU Gold)

Typical Circuits

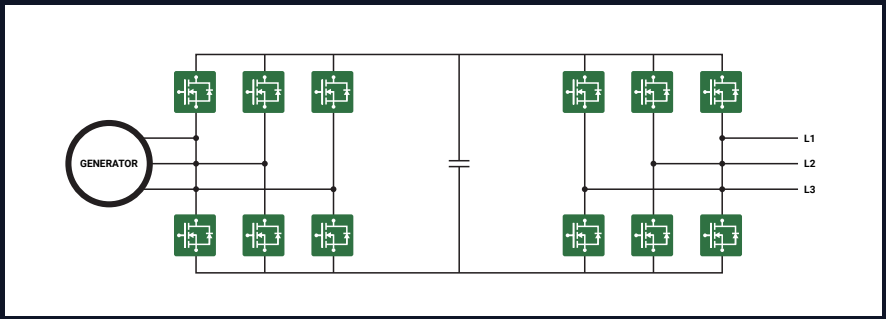
PFC and 3-Phase Motor Drive using 650 V SiC MOSFETs and Diodes



Transformer-less, 3-phase, 3-level NPC, using 1200 V SiC MOSFETs and Diodes

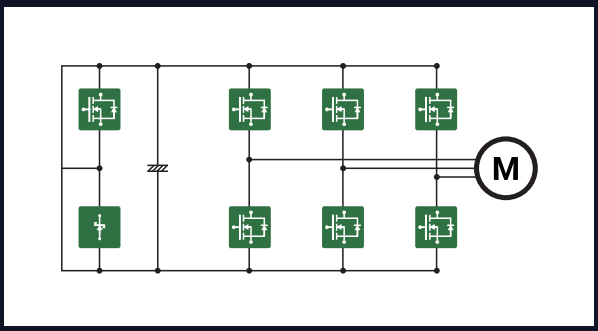


4-quadrant Full-Power Converter using 1700 V SiC MOSFETs

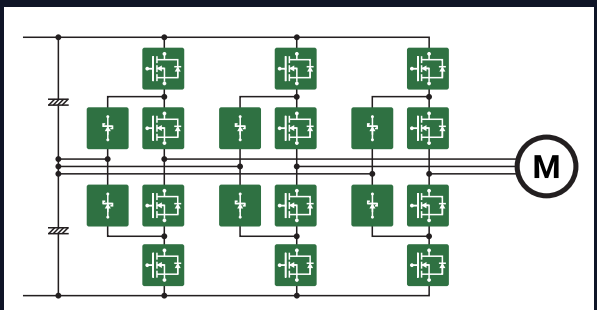


Locomotive Traction Inverters using 3.3 kV & 6.5 kV SiC MOSFETs and Diodes

2-Level Inverter (6.5 kV)



3-Level Inverter (3.3 kV)



Navitas GeneSiC™

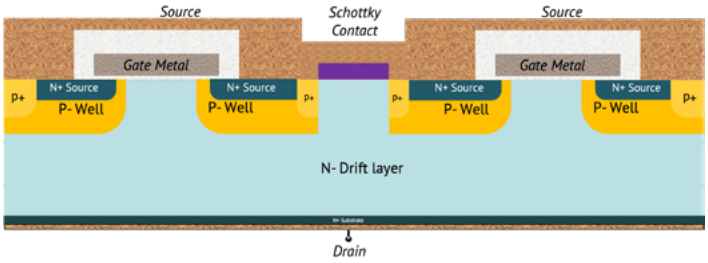
Built to the Highest Level of Reliability

High-voltage pioneers

Robust, high-voltage, high-efficiency SiC MOSFETs, critical for reliable, harsh-environment, high-power applications.

Unique, advanced, integrated 6.5 kV technology

- Double-implanted metal oxide semiconductor (DMOSFET)
- Monolithically-integrated Junction barrier Schottky (JBS) rectifier
- Superior high-power performance



Higher efficiency bi-directional performance

- Temperature independent switching
- Fast (low switching loss) and cool (low conduction losses)
- Longer-term reliability
- Easy-to-parallel for high power (V_{TH} stability)

Alternative Energy
Solar and Wind
Inverters

Transportation
Rail and Ship-board

Automotive
Electric Vehicles and
Fast Chargers

Power Grid
HVDC Transmission
and FACTS

Industrial
Power Supply, Traction
and Welding

Aerospace and Defense
High Temperature

High power modules & die sales

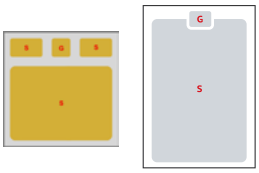
GeneSiC SiCPAK™ modules and bare-die enable expanded applications ranging from 10s kW to MW in rail, EV, fast charging, industry, solar, wind and energy storage.

GeneSiC SiCPAK™ modules have been designed for superior performance and robustness, while meeting industry-standard footprint with pin-to-pin combability.

- Epoxy-Resin Potting Technology for High Reliability
  - Improved Temperature Cycling
  - Improved Power Cycling
- 'Gen3 Fast' SiC MOSFETs with Industry-Leading Current Density (A/mm^2)
- Optimized Low-Inductance Design with Industry-Standard Press-Fit Connections with built-in NTC and Pin-to-Pin Compatibility

Part number	Voltage (V)	$R_{DS(ON)}$ per switch @ 18V (mΩ)	Topology	Package
G3F09MT12FB2(-T)	1200	9	Half-Bridge	SiCPAK F (33.8mm x 62.8mm)
G3F17MT12FB2(-T)		17		
G3F18MT12FB4(-T)		18	Full-Bridge	
G3F05MT12GB2(-T)		5	Half-Bridge	SiCPAK G (56.7mm x 62.8mm)
G3F09MT12GB4(-T)		9	Full-Bridge	
G3F09MT12G3T(-T)		9	3L-T-NPC	

**(-T) Thermal Interface Material Option*



GeneSiC MOSFET and diode technologies range from 650 V to 6500 V using trench-assisted planar technology, to provide lowest $R_{DS(ON)}$ positive temp. coefficient to enable highest efficiency at real operating temperatures. Die has been optimized for different bonding and attach styles with various metallizations including aluminum and gold.

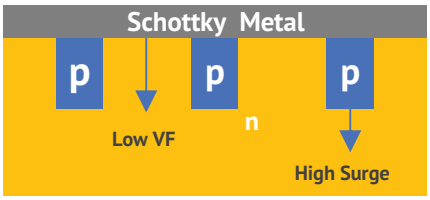
Navitas GeneSiC™

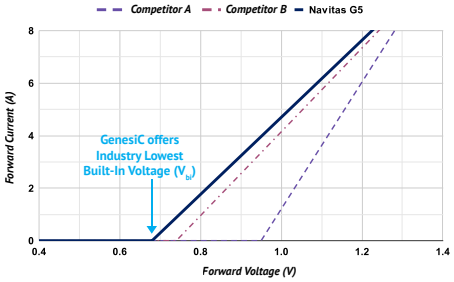
650 V MPS™ Diodes

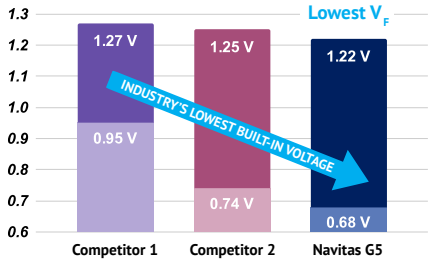
GeneSiC's new 5th-generation 650 V Merged-PiN Schottky (MPS™) diodes integrate a unique PiN-Schottky structure, delivering 'low-built-in Voltage-Biasing' ("low knee") for highest efficiency across all load conditions with superior robustness. Applications include PFC in server/telecom power supplies, industrial motor drives, solar inverters, LCD/LED TVs, and lighting.

Merged-PiN schottky (MPS™) with low-built-in voltage-biasing technology

A novel GeneSiC merged-PiN Schottky design combines the best features from both PiN and Schottky diode structures, producing the lowest forward voltage drop (V_F), high surge-current capability (I_{FSM}), and minimized temperature-independent switching losses. Proprietary thin-chip technology further reduces V_F and improves thermal dissipation for cooler operation.



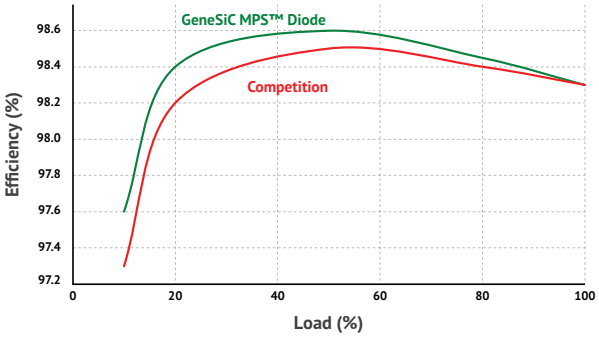




Superior figure-of-merit (FoM) drives high efficiency

Gen-5 MPS Diodes are ideal in PFC circuits in continuous-current mode (CCM) due to excellent figure of merit, comprising of a low V_F of 1.3 V, minimized capacitive charge (Q_C). In Addition, zero reverse recovery charge improves PFC MOSFET turn-on performance. The result is a cooler, more reliable system.

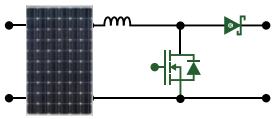
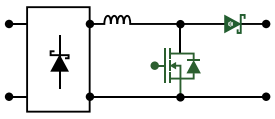
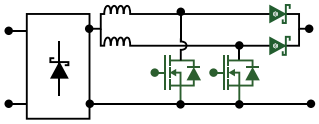
3 kW Interleaved Boost PFC



At light load, T_j = 25°C, at full load, T_j = 125°C

Features	Benefits
Low V_F (1.3 V) conduction losses	High system efficiency
Excellent FoM (V_F.Q_C)	Very high frequency operation
100% avalanche (UIL) tested	Reduced EMI
Exceptional dV/dt ruggedness	Superior robustness
Lowest reverse leakage current	Excellent reliability
Low thermal resistance	Reduced cooling requirements

Typical application circuits

Boost (Solar Inverter)		Boost converters are used in Solar inverters to generate a fixed, higher DC voltage. SiC diodes in QFN8x8 and TO-252 offering highest efficiencies for <3 kW microinverters.
CCM PFC		For PFC applications such as continuous-current mode (CCM) that require fastest reverse recovery to minimize switching losses and increase system efficiency, the TO-220-2 offer excellent performance with high thermal dissipation.
Interleaved PFC		The TO-247-3 package offers great flexibility for higher power density and BOM reduction in applications like the interleaved power factor correction (PFC) that shares a common cathode between two diodes.

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GeneSiC™

SiC Schottky MPS™ Diodes

Merged-PIN Schottky (MPS) Diodes combine two beneficial features from the PIN and Schottky diode. The PIN sustains excessive surge currents with low leakage, while the Schottky element offers low forward-voltage drop and fast-switching characteristics. Target applications include PFC, Boost, and high-voltage, higher-power motor drives.

V_{RRM} (V)	I_F (A)	DO-214	PQFN 88	TO-252-2	TO-263-7 (D2PAK-7L)	TO-220-2	TO-247-2	TO-247-3	SOT-227	Bare Die
650	1	GB01SLT06-214								
	4		*GE04MPS06Q*	*GE04MPS06E*		*GE04MPS06A*				
	6		*GE06MPS06Q*	*GE06MPS06E*		*GE06MPS06A*				
	8		*GE08MPS06Q*	*GE08MPS06E*		*GE08MPS06A*				
	10		*GE10MPS06Q*	*GE10MPS06E*		*GE10MPS06A*				
	12		*GE12MPS06Q*	*GE12MPS06E*		*GE12MPS06A*				
	16							*GE2X8MPS06D*		
	20							*GE2X10MPS06D*		
	24							*GE2X12MPS06D*		
	30				GD30MPS06J	GD30MPS06A	GD30MPS06H			
	60						GD60MPS06H	GD2X30MPS06D	GD2X30MPS06N	
	100								GD2X100MPS06N	
	120								GD2X60MPS06N	
	200								GD2X100MPS06N	
	300								GD2X150MPS06N	
1200	1	GB01SLT12-214								
	2	GB02SLT12-214		GD02MPS12E						
	10			GD10MPS12E		GD10MPS12A	GD10MPS12H			GD10MPS12-CAx
	20					GD20MPS12A	GD20MPS12H	GD2X10MPS12D		GD20MPS12-CAx
	30				GD30MPS12J		GD30MPS12H			GD30MPS12-CAx
	40							GD2X20MPS12D		
	50						GD50MPS12H			GD50MPS12-CAx
	60							GD2X30MPS12D	GD2X30MPS12N	
	100								GD2X50MPS12N	GD100MPS12-CAx
	200								GD2X100MPS12N	
1700	5				GD05MPS17J		GD05MPS17H			
	10						GD10MPS17H			
	15						GD15MPS17H			
	25						GD25MPS17H			
	50								GD2X25MPS17N	
	60						GD60MPS17H			
	75									GD75MPS17-CAx
	150								GD2X75MPS17N	
3300	5			GC05MPS33J						

Engineering Samples

Navitas

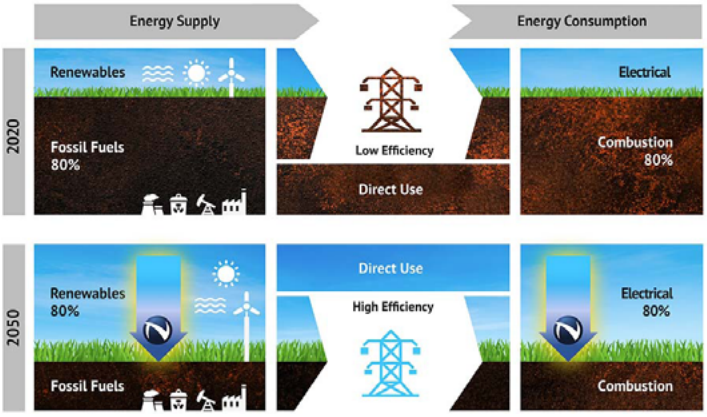
GeneSiC™

Electrify Our World™

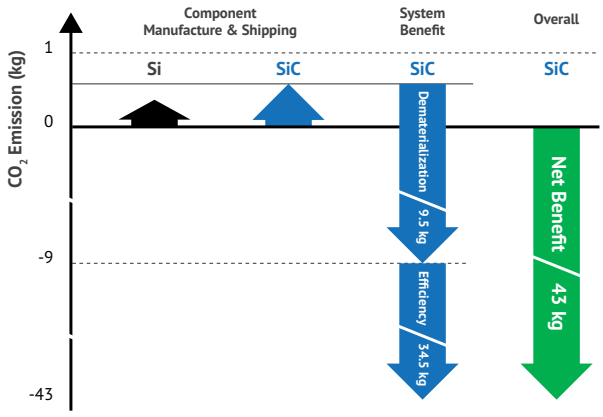
In May 2022, Navitas announced that it was the world's first semiconductor company to achieve CarbonNeutral®-company certification, another milestone towards Navitas' mission to *"Electrify Our World"* and to help Navitas' customers achieve their own sustainability goals.

Silicon Carbide technology enables CO_2 reduction by increasing system efficiency and through 'dematerialization' – using less case material, heatsink, PCBs, etc. vs. legacy silicon IGBTs.

Electrify Our World™



Every GeneSiC MOSFET shipped saves over 40 kg CO_2



Each KATEK coolcept fleX Steca solar inverter uses 16x GeneSiC G3R75MT12J SiC MOSFETs per 4.6 kW unit. The 1,200 V, 75 mΩ-rated devices are used in a two-level converter, with bi-directional boost converters and an H4-topology for AC voltage output. Increased switching frequency shrinks the size and weight.

"Next-generation GeneSiC technology has enabled a major step in system performance without compromising our high engineering standards, especially regarding EMI," said Dr. Peter Grabs, KATEK's Director of Innovation, Research and Development. "Navitas' excellent quality – with zero failures – and consistent, short lead-time delivery are critical success factors as we expand production into new markets."

Exide's high frequency chargers convert 220 V AC power to a battery-level voltage between 24 and 80 V for lead-acid and lithium-ion battery-powered industrial vehicles. The 7 kW module uses GeneSiC G3R60MT07D (750 V) MOSFETs and GD10MPS12A (1,200 V) MPS Schottky diodes, with frequency-optimized architecture. The same platform can be upgraded to 10 kW, with 4 modules in parallel to provide 40 kW of reliable fast-charging power.

"Exide Technologies delivers complete, carefully controlled fast-charging with close system monitoring for critical material-handling equipment, running 24/7," said Dr. Dominik Margraf, Director Product Management Motion at Exide Technologies. "Navitas' GeneSiC technology is easy-to-use, with excellent support, increased system efficiency, and cooler operation."

Contact your local distributor or sales rep to discover the power of GeneSiC technology!

- *Samples available immediately with short volume-production lead times*
- *Broadest silicon carbide portfolio – over 140 products in mass production (from 650 V to 6.5 kV)*

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