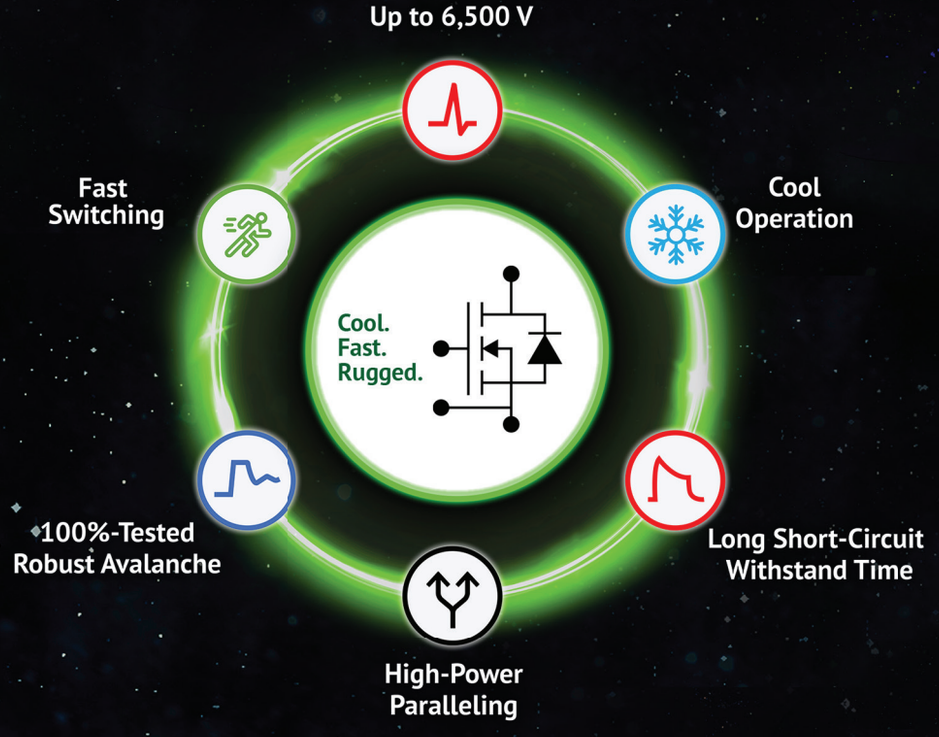




# GeneSiC™ Power Devices

## Electrify Our World ™



GeneSiC

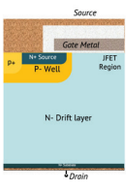
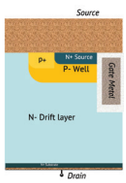
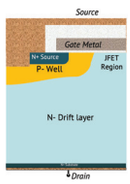
# Markets and Technology

**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*

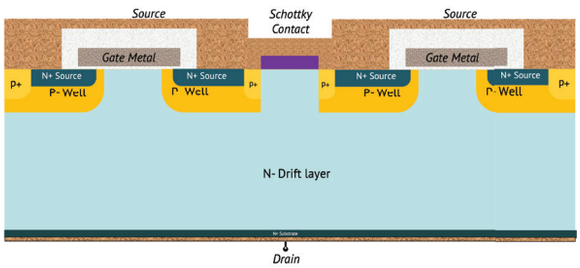
SiC MOSFETs offer superior conductivity and switching performance compared to silicon (Si) due to their 'wide bandgap' characteristics and high electric-field strength. However, traditional designs using legacy planar or trench techniques must compromise between manufacturability, performance, and/or 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* |
|---|---|---|---|
| |  |  |  |
| *Manufacturability* | » *Repeatable*<br>» *High yield*<br>» *Low cost* | » *Inconsistent trench etch*<br>» *Lower yields*<br>» *High cost* | » *Repeatable*<br>» *High yield*<br>» *Low cost* |
| *Performance* | » *High $R_{DS(ON)}$ / area*<br>» *Slow switching*<br>» *High $R_{DS(ON)}$ / Δ temp* | » *Lower $R_{DS(ON)}$ / area*<br>» *Faster switching*<br>» *High $R_{DS(ON)}$ / Δ temp* | » *Lower $R_{DS(ON)}$ / area*<br>» *Fastest switching*<br>» *Lowest $R_{DS(ON)}$ / Δ temp* |
| *Reliability* | » *Rugged gate oxide (stable $V_{TH}$)* | » *Failures due to non-uniform gate oxide*<br>» *Lower short-circuit capability* | » *Highest 100% tested avalanche*<br>» *Long short-circuit withstand time*<br>» *Rugged gate oxide (stable $V_{TH}$)* |

# High Voltage Pioneers

## GeneSiC have pioneered robust, high-voltage, high-efficiency SiC MOSFETs which are 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

***Automotive***
Electric Vehicles and Fast Chargers

***Industrial***
Power Supply, Traction and Welding

***Transportation***
Rail and Ship Board

***Power Grid***
HVDC Transmission and FACTS

***Aerospace and Defense***
High Temperature

***Oil Drilling***
Rectifiers and Motor Drives

# Widest Range of SiC MOSFETs 750 V - 6.5 kV

| $V_{BR(DSS)}$ (V) | $R_{DS(ON)}$ typ. (mΩ) | TO-263-7 (D2PAK-7L) | TO-247-3 | TO-247-4 | SOT-227 | Bare Chip |
|---|---|---|---|---|---|---|
| 750 | 10 | | | | | *G3R10MT07-CAx* |
| | 12 | | | | | *G4R12MT07-CAx* |
| | 60 | G3R60MT07J | G3R60MT07D | G3R60MT07K | | |
| 1200 | 10 | | | | | *G4R10MT12-CAx* |
| | 12 | | | G3R12MT12K | | G3R12MT12-CAL |
| | 20 | | | G3R20MT12K | G3R20MT12N | G3R20MT12-CAL |
| | 30 | G3R30MT12J | | G3R30MT12K | | G3R30MT12-CAL |
| | 40 | G3R40MT12J | G3R40MT12D | G3R40MT12K | | |
| | 75 | G3R75MT12J | G3R75MT12D | G3R75MT12K | | |
| | 160 | G3R160MT12J | G3R160MT12D | | | |
| | 350 | G3R350MT12J | G3R350MT12D | | | |
| 1700 | 20 | | | G3R20MT17K | G3R20MT17N | G3R20MT17-CAL |
| | 45 | | G3R45MT17D | G3R45MT17K | | G3R45MT17-CAL |
| | 160 | G3R160MT17J | G3R160MT17D | | | |
| | 450 | G3R450MT17J | G3R450MT17D | | | |
| | 1000 | G2R1000MT17J | G2R1000MT17D | | | |
| 3300 | 15 | | | | | *G2R15MT33-CAL* |
| | 50 | | | G2R50MT33K | | G2R50MT33-CAL |
| | 120 | G2R120MT33J | | | | G2R120MT33-CAL |
| | 1000 | G2R1000MT33J | | | | |
| 6500 | 50 | | | | | *G2R50MT65-CAL* |
| | 300 | | | | | *G2R300MT65-CAL* |
| | 50 | | | | | *G2R50MS65-CAL* |
| | 325 | | | | | *G2R325MS65-CAL* |

*Engineering Samples*

GeneSiC

# Cool. Fast.

**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 $E_{XX}$)?***

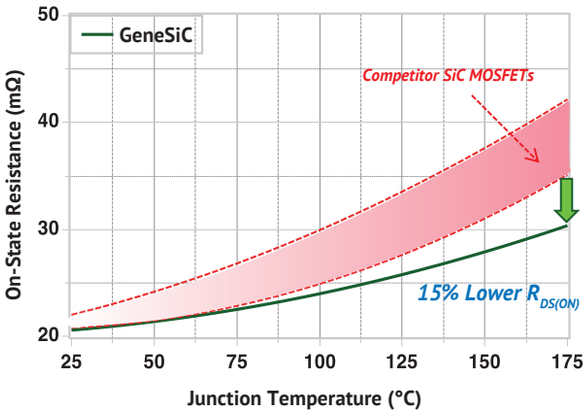
**For each question, we must understand the answer in both 'hard-switch' and 'soft-switch' topologies, and under tough high-temperature and high-speed conditions. Combined, a high-temperature, high-speed (frequency) figure-of-merit (FoM) is critical for system performance and reliability.**

| 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 |

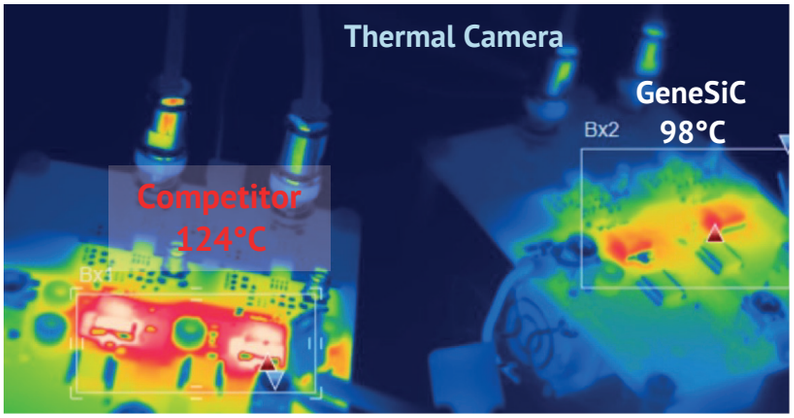
***Lowest power loss at high temp, high speed*** = ***Highest Efficiency, Energy Savings Small Size, Light Weight, Low System Costs!***

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

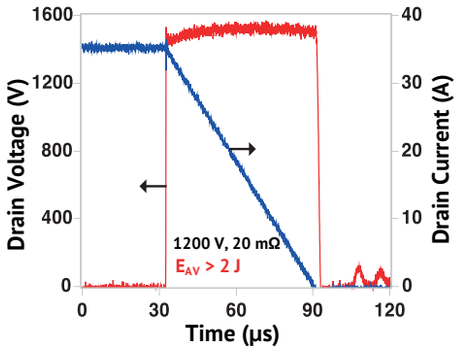



- ***GeneSiC vs. competitor SiC FET***
  - » 1200 V, 20 mΩ, TO-247-4L
  - » Higher drain current
  - » Lower conduction losses
  - » Cooler operation

- ***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

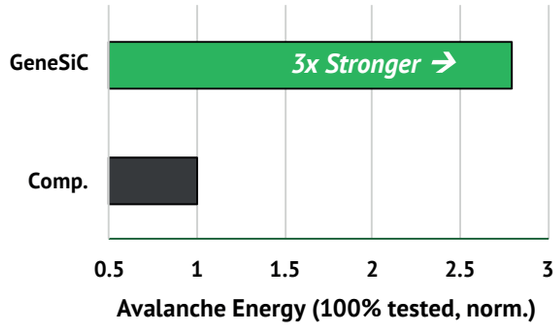
## 100%-Tested Avalanche

### Highest published capability to handle excess energy in fault condition



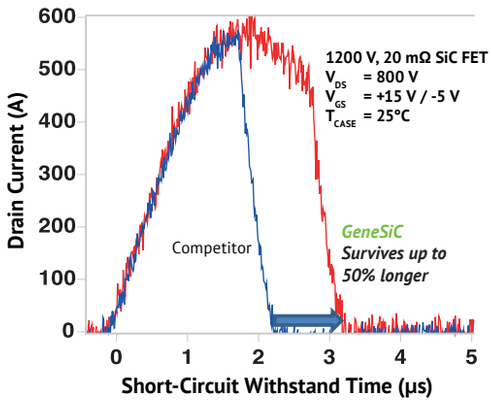

*refer to datasheet for EAS rating

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

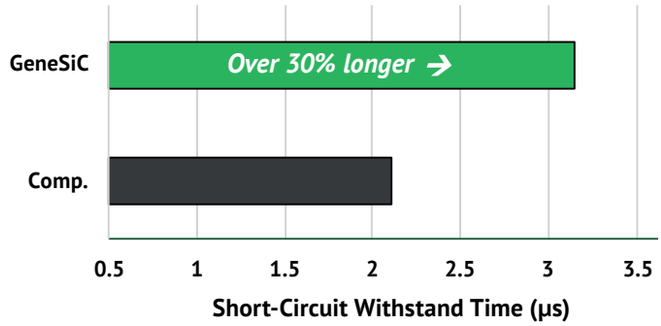



## Long Short-Circuit Withstand Time

### World-class survival duration in fault condition



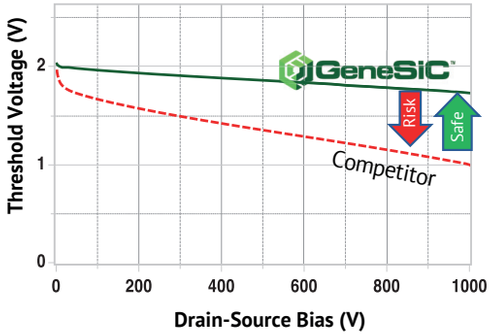

Critical to prevent failures like motor short circuit where the FET faces full voltage ($V_{DD}$) in ON-state.



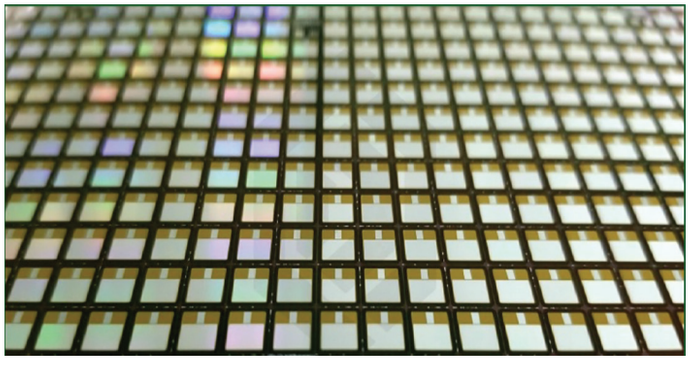

## High Power Paralleling

### Matching currents (Stable $V_{TH}$)

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

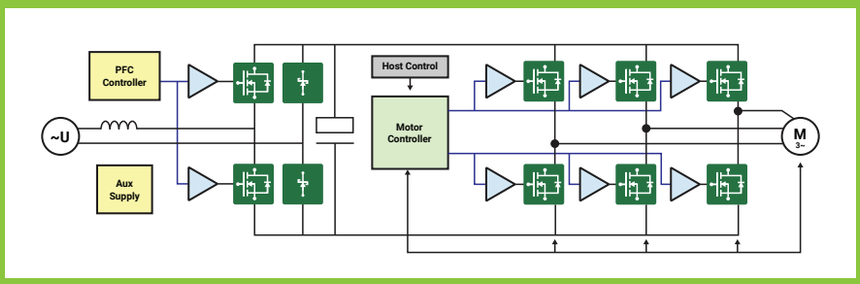



GeneSiC packaged and bare-die FETs can be paralleled reliably for high-power applications

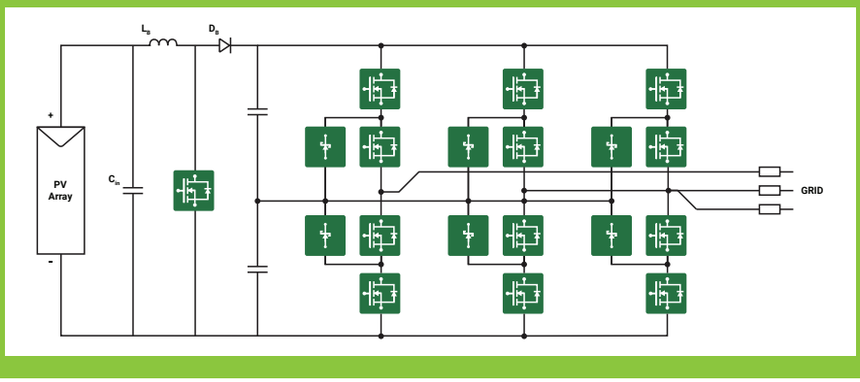


# Typical Circuits

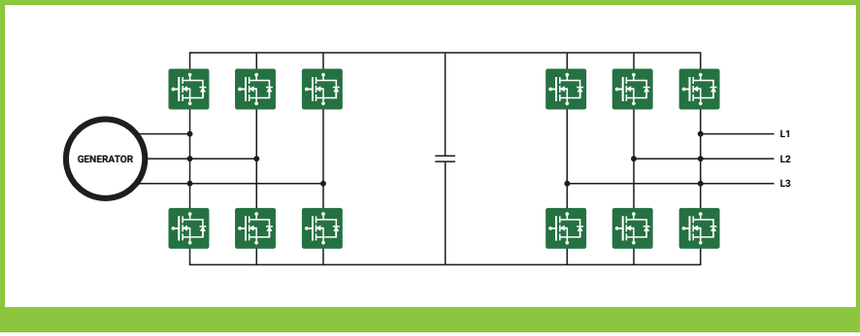
## PFC and 3-Phase Motor Drive using 750 V SiC MOSFETs and Diodes




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

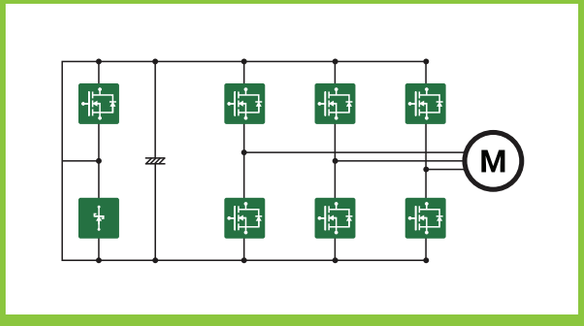



## 4-quadrant Full-Power Converter using 1700 V SiC MOSFETs

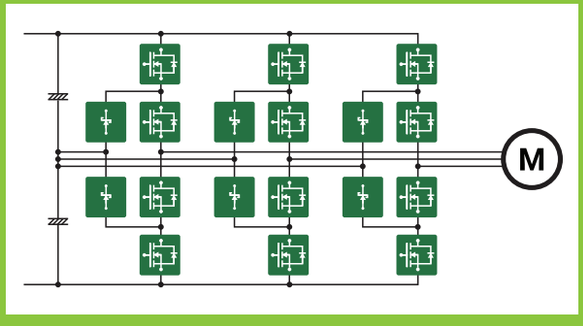



## Locomotive Traction Inverters using 3.3 kV & 6.5 kV SiC MOSFETs and Diodes

2-Level Inverter (6.5 kV)

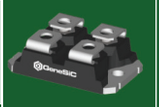



3-Level Inverter (3.3 kV)



# 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 | TO-252-2 | TO-263-7 (D2PAK-7L) | TO-220-2 | TO-247-2 | TO-247-3 | SOT-227 | Bare Chip |
| 650 | 1 | GB01SLT06-214 | | | | | | | |
| | 4 | | GE04MPS06E | | GE04MPS06A | | | | |
| | 6 | | GE06MPS06E | | GE06MPS06A | | | | |
| | 8 | | GE08MPS06E | | GE08MPS06A | | | | |
| | 10 | | GE10MPS06E | | GE10MPS06A | | | | |
| | 16 | | | | | | GE2X8MPS06D | | |
| | 20 | | | | | | GE2X10MPS06D | | |
| | 30 | | | GD30MPS06J | GD30MPS06A | GD30MPS06H | | | |
| | 60 | | | | | GD60MPS06H | GD2X30MPS06D | GD2X30MPS06N | |
| | 120 | | | | | | | GD2X60MPS06N | |
| | 200 | | | | | | | GD2X100MPS06N | |
| | 300 | | | | | | | GD2X150MPS06N | |
| 1200 | 1 | GB01SLT12-214 | GB01SLT12-252 | | | | | | |
| | 2 | GB02SLT12-214 | GD02MPS12E | | GC02MPS12-220 | | | | |
| | 5 | | GC05MPS12-252 | | | | | | |
| | 8 | | GC08MPS12-252 | | GC08MPS12-220 | | | | |
| | 10 | | GD10MPS12E | | GD10MPS12A | GD10MPS12H | GC2X5MPS12-247 | | |
| | 15 | | | | GC15MPS12-220 | GC15MPS12-247 | GC2X8MPS12-247 | | |
| | 20 | | | | GD20MPS12A | GD20MPS12H | GD2X10MPS12D | | |
| | 30 | | | | | GD30MPS12H | GC2X15MPS12-247 | | GD30MPS12-CAL |
| | 40 | | | | | | GD2X20MPS12D | | |
| | 50 | | | | | GD50MPS12H | | | GD50MPS12-CAL |
| | 60 | | | | | | GD2X30MPS12D | GD2X30MPS12N | |
| | 100 | | | | | | | GD2X50MPS12N | GD100MPS12-CAL |
| | 200 | | | | | | | GD2X100MPS12N | |
| 1700 | 5 | | | GB05MPS17-263 | | GD05MPS17H | | | |
| | 10 | | | | | GD10MPS17H | | | |
| | 15 | | | | | GD15MPS17H | | | |
| | 25 | | | | | GD25MPS17H | | | |
| | 50 | | | | | GB50MPS17-247 | | | |
| | 60 | | | | | GD60MPS17H | | | |
| | 75 | | | | | | | | GD75MPS17-CAL |
| | 100 | | | | | | | GB2X50MPS17-227 | |
| | 150 | | | | | | | GD2X75MPS17N | |
| 3300 | 0.3 | GAP3SLT33-214 | | | GAP3SLT33-220 (FP) | | | | |
| | 5 | | GC05MPS33J | | | | | | |
| | 50 | | | | | GC50MPS33H | | | GC50MPS33-CAL |

GeneSiC

# *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)*

## *Sales & Distribution Support*

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|---|---|
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| Dacpol SP. Z O. O | www.dacpol.eu |
| TME Elecronic Components | www.tme.com |
| Boran Technologies Ltd. | www.boran.co.il |
| empa:::electronics | www.empa.com |

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| Korea | Melbrin | www.melbrin.com |
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| Taiwan | Conquer Semiconductor International Corp. | www.conquer-semi.com |
| Japan | Semisolution Supply | www.semisolution-s.com |
| Japan | Chip1Stop | www.chip1stop.com |

**Navitas Semiconductor**
**3520 Challenger Street, Torrance, CA 90503, USA**
**Navitas +1 844-654-2642, info@navitassemi.com**
**GeneSiC +1 703-996-8200, sales@genesicsemi.com**
**www.navitassemi.com** **www.genesicsemi.com**

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