



Powering the
SiC evolution™

Harnessing the Power of Silicon Carbide to Shape a **Sustainable and Efficient Future**

SemiQ | www.semiq.com/

Technology
Partner



800.348.5580
630.208.2200



rellpower.com
rellpower@rell.com

High Power Silicon Carbide Semiconductor Devices



SemiQ specializes in providing high-quality, efficient standard, and custom Silicon Carbide (SiC) Power Semiconductors for high-voltage applications. Our product portfolio includes MOSFETs and diodes, available in discrete, module and bare die that combine high-performance with industry-leading reliability.

For over a decade, SemiQ's experienced team has been working with customers from various application areas, including solar energy, EV charging, automotive, medical, and energy storage. From the initial concept stage through prototyping and production, we help design, test, and deploy high-density and optimized solutions, providing exceptional service and engineering support to all our partners within the shortest possible timeframe.

SemiQ | www.semiq.com/

Technology
Partner

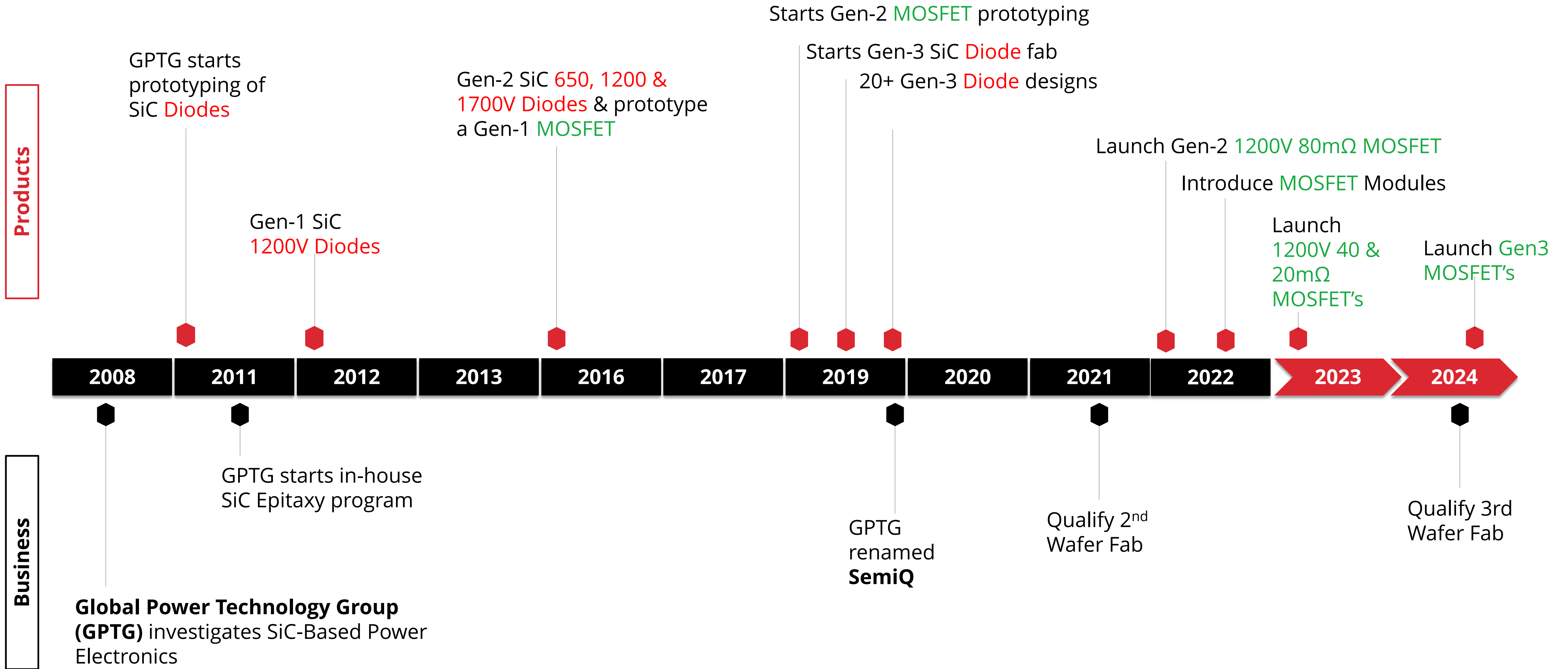


800.348.5580
630.208.2200

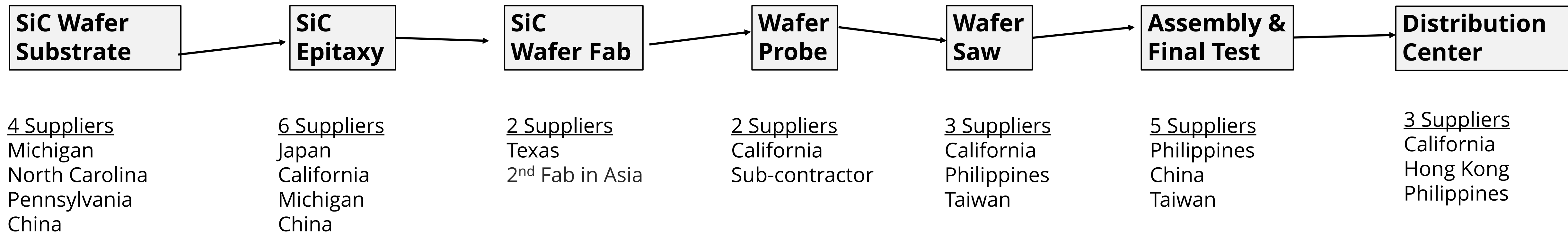


rellpower.com
rellpower@rell.com

Company Timeline



Redundant Supply Chain



- SemiQ has built a redundant SiC supply chain for dependability and continuity
 - Most other suppliers will be limited to one production wafer fab
 - SemiQ SiC Diodes and MOSFETs are now being built in production in two wafer fabs, with a 3rd fab being qualified in 2024

Applications



Solar Energy



EV Charging



Automotive



Medical



Energy Storage

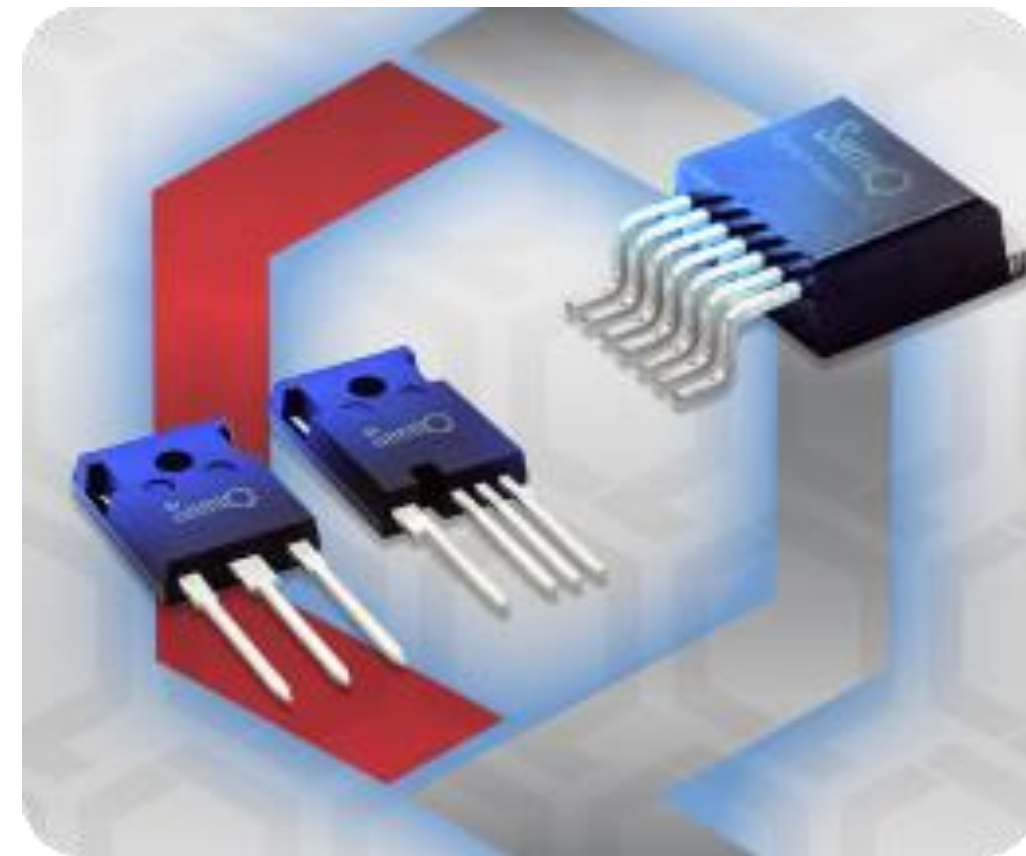
Product Overview



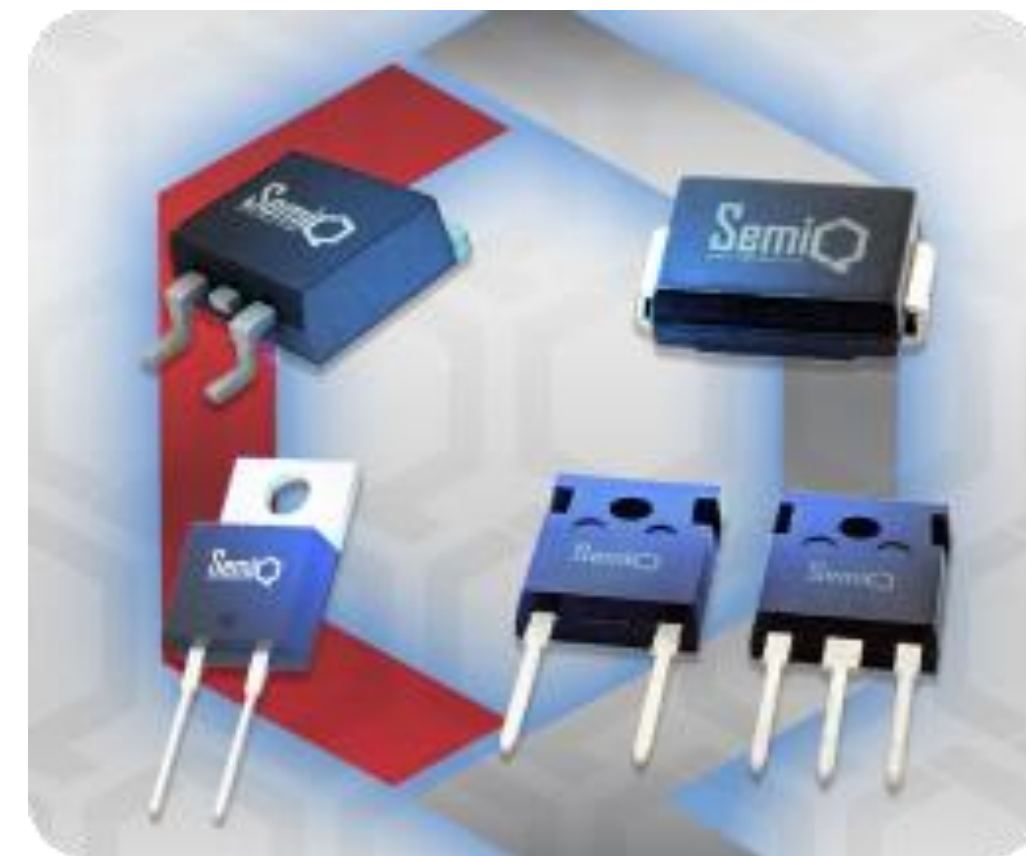
SemiQ Diodes and MOSFETs are available in standardized packages including TO-220, TO-247, TO-263, SOT-227, Half-Bridge and Full-Bridge Modules, as well as Known Good Die.



Modules



MOSFETs



Diodes



Known Good Die

Gen3 650V/1200V/1700V SiC Diode Bare Die



| Part Number | Voltage [V] | Current [A] |
|--------------|-------------|-------------|
| GP3D006A065X | 650 | 6 |
| GP3D008A065X | 650 | 8 |
| GP3D010A065X | 650 | 10 |
| GP3D012A065X | 650 | 12 |
| GP3D020A065X | 650 | 20 |
| GP3D030A065X | 650 | 30 |
| GP3D050A065X | 650 | 50 |
| GP3D010A120X | 1200 | 10 |
| GP3D015A120X | 1200 | 15 |
| GP3D020A120X | 1200 | 20 |
| GP3D030A120X | 1200 | 30 |
| GP3D050A120X | 1200 | 50 |
| GP3D005A170X | 1700 | 5 |
| GP3D010A170X | 1700 | 10 |
| GP3D020A170X | 1700 | 20 |

SemiQ | www.semiq.com/

Technology
Partner



800.348.5580
630.208.2200



rellpower.com
rellpower@rell.com

Gen3 650V/1200V/1700V SiC Diode Bare Die



| Part Number | Voltage [V] | Current [A] | Die Size (mm ²) | Description |
|--------------|-------------|-------------|-----------------------------|---------------|
| GP3D006A065X | 650 | 6 | 1.57 x 1.57 | In production |
| GP3D008A065X | 650 | 8 | 1.76 x 1.76 | In production |
| GP3D010A065X | 650 | 10 | 1.92 x 1.92 | In production |
| GP3D012A065X | 650 | 12 | 1.5 x 2.9 | In production |
| GP3D020A065X | 650 | 20 | 2.39 x 2.39 | In production |
| GP3D030A065X | 650 | 30 | 2.86 x 2.86 | In production |
| GP3D050A065X | 650 | 50 | 3.5 x 3.5 | In production |
| GP3D010A120X | 1200 | 10 | 2.4 x 2.4 | In production |
| GP3D015A120X | 1200 | 15 | 2.12 x 4.1 | In production |
| GP3D020A120X | 1200 | 20 | 3.25 x 3.25 | In production |
| GP3D030A120X | 1200 | 30 | 3.9 x 3.9 | In production |
| GP3D050A120X | 1200 | 50 | 4.93 x 4.93 | In production |
| GP3D005A170X | 1700 | 5 | 2.16 x 2.16 | In production |
| GP3D010A170X | 1700 | 10 | 2.91 x 2.91 | In production |
| GP3D020A170X | 1700 | 20 | 3.95 x 3.95 | In production |
| GP3D050A170X | 1700 | 50 | 5.00 x 7.20 | Under Qual |

Gen3 Diode Discretes

| Part Number | Voltage [V] | Current [A] | Package | |
|--------------|-------------|-------------|--------------|-----------|
| GP3D006A065A | 650V | 6 | TO-220-2L | |
| GP3D006A065F | | 6 | TO-220-2L-FP | |
| GP3D008A065A | | 8 | TO-220-2L | |
| GP3D008A065F | | 8 | TO-220-2L-FP | |
| GP3D010A065A | | 10 | TO-220-2L | |
| GP3D010A065B | | 10 | TO-247-2L | |
| GP3D012A065A | | 12 | TO-220-2L | |
| GP3D012A065B | | 12 | TO-247-2L | |
| GP3D016A065U | | 2X8 | TO-247-3L | |
| GP3D020A065A | | 20 | TO-220-2L | |
| GP3D020A065B | | 20 | TO-247-2L | |
| GP3D020A065U | | 2X10 | TO-247-3L | |
| GP3D024A065U | | 2X12 | TO-247-3L | |
| GP3D030A065B | | 30 | TO-247-2L | |
| GP3D040A065U | | 2X20 | TO-247-3L | |
| GP3D050A065B | | 50 | TO-247-2L | |
| GP3D010A120S | | 1200V | 10 | DO-214AB |
| GP3D010A120A | | | 10 | TO-220-2L |
| GP3D010A120B | 10 | | TO-247-2L | |
| GP3D015A120A | 15 | | TO-220-2L | |
| GP3D015A120B | 15 | | TO-247-2L | |
| GP3D020A120A | 20 | | TO-220-2L | |
| GP3D020A120B | 20 | | TO-247-2L | |
| GP3D020A120U | 2X10 | | TO-247-3L | |
| GP3D030A120B | 30 | | TO-247-2L | |
| GP3D030A120U | 2X15 | | TO-247-3L | |
| GP3D040A120U | 2X20 | | TO-247-3L | |
| GP3D050A120B | 50 | | TO-247-2L | |
| GP3D060A120U | 2X30 | | TO-247-3L | |
| GP3D005A170B | 1700V | | 5 | TO-247-2L |
| GP3D010A170B | | | 10 | TO-247-2L |
| GP3D020A170B | | 20 | TO-247-2L | |



TO-220-2L
A-Suffix



TO-247-2L
B-Suffix



TO-247-3L
U-Suffix



TO-220-2L-FP
F-Suffix



DO-214AB
S-Suffix

1700V Diodes: TO247-2L and SOT-227

GHXS100B170S-D3

| | |
|--------------------|--------|
| VDC | 1700 V |
| I _F | 100 A |
| T _{j,max} | 175 °C |

GP3D050A170B

| | |
|--------------------|--------|
| VDC | 1700 V |
| Q _C | 515 nC |
| I _F | 50 A |
| T _{j,max} | 175 °C |

1700V SiC Power Module Dual Diode Pack

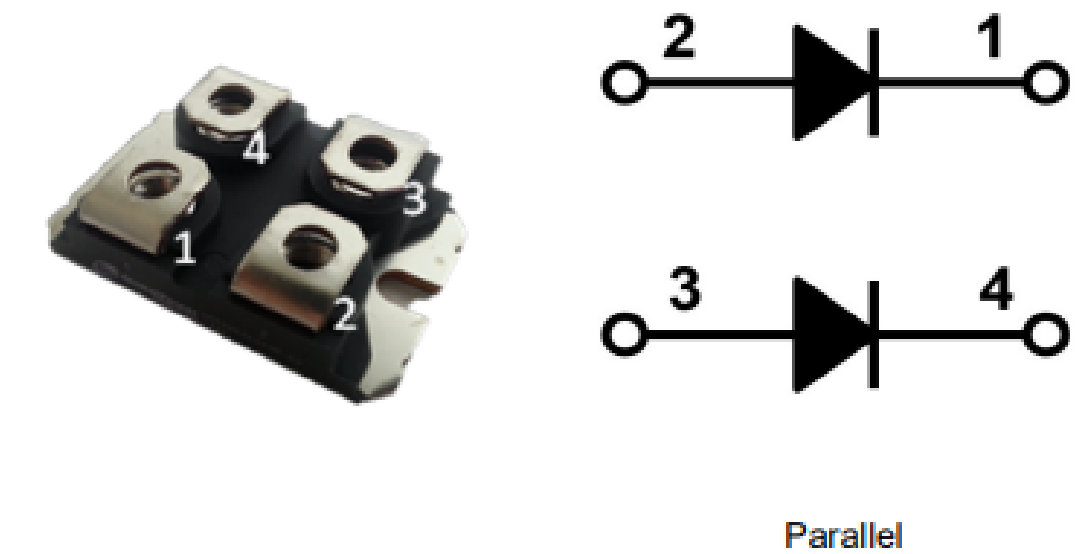
Features

- SiC Schottky Diode
 - Zero reverse recovery
 - Zero forward recovery
 - Temperature independent switching behavior
 - Positive temperature coefficient on V_F
- Low stray inductance
- High junction temperature operation
- All parts tested to greater than 1,870V

Benefits

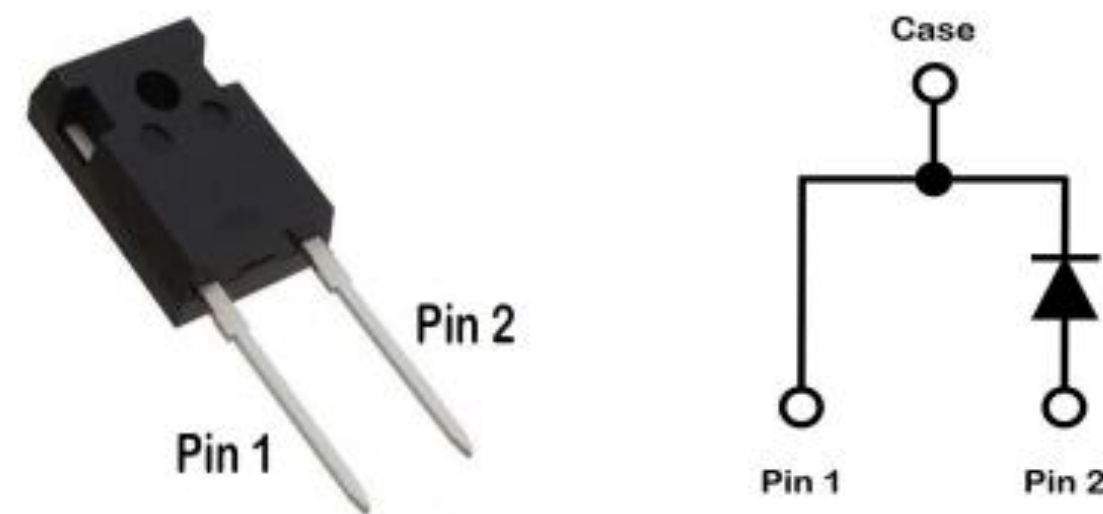
- Outstanding performance at high frequency operation
- Low loss and low EMI noise
- Very rugged and easy mounting
- Internally isolated package (AIN)
- Low junction to case thermal resistance
- Easy paralleling due to positive T_C of V_F
- RoHS compliant

Package



| Part # | Package | Marking |
|-----------------|---------|-----------------|
| GHXS100B170S-D3 | SOT-227 | GHXS100B170S-D3 |

Package



| Part # | Package | Marking |
|--------------|-----------|-----------|
| GP3D050A170B | TO-247-2L | 3D050A170 |

SiC™ 1700V SiC Schottky Diode

Features

- Unipolar rectifier with surge current
- Zero reverse recovery current
- Fast, temperature-independent switching
- Avalanche tested to 1250mJ*
- All parts tested to greater than 1,870V

Benefits

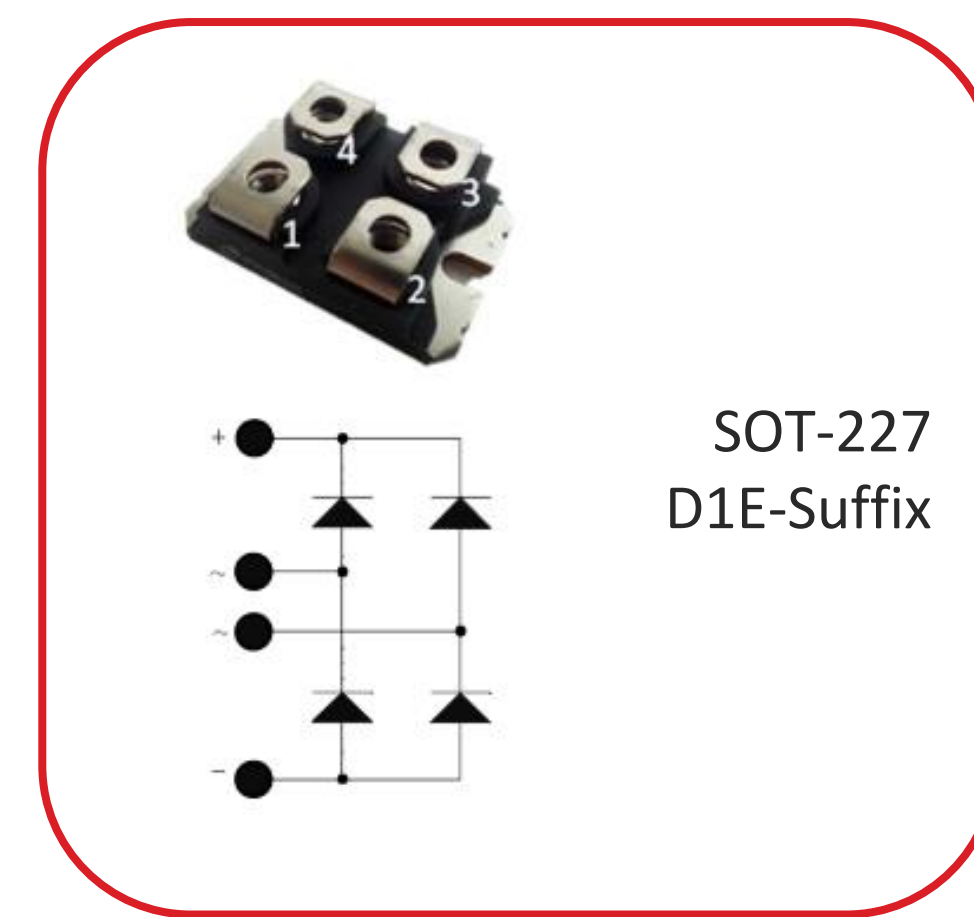
- Near zero switching loss
- Higher efficiency
- Reduced heat sink requirements
- Easy to parallel

Applications

Gen3 Diode Modules



| Product | Voltage | Current | Package/Topology |
|------------------|----------|---------|------------------|
| GHXS010A060S-D3 | 600/650V | 10A | SOT-227/Parallel |
| GHXS020A060S-D3 | | 20A | SOT-227/Parallel |
| GHXS030A060S-D3 | | 30A | SOT-227/Parallel |
| GHXS030A060S-D1E | | 30A | SOT-227/Bridge |
| GHXS050B065S-D3 | | 50A | SOT-227/Parallel |
| GHXS100B065S-D3 | | 100A | SOT-227/Parallel |
| GHXS015A120S-D3 | 1200V | 15A | SOT-227/Parallel |
| GHXS030A120S-D3 | | 30A | SOT-227/Parallel |
| GHXS030A120S-D1E | | 30A | SOT-227/Bridge |
| GHXS045A120S-D3 | | 45A | SOT-227/Parallel |
| GHXS060A120S-D3 | | 60A | SOT-227/Parallel |
| GHXS050B120S-D3 | | 50A | SOT-227/Parallel |
| GHXS100B120S-D3 | | 100A | SOT-227/Parallel |
| GHXS300A120S7D5 | | 300A | S7 Half Bridge |
| GHXS400A120S7D5 | | 400 | S7 Half Bridge |

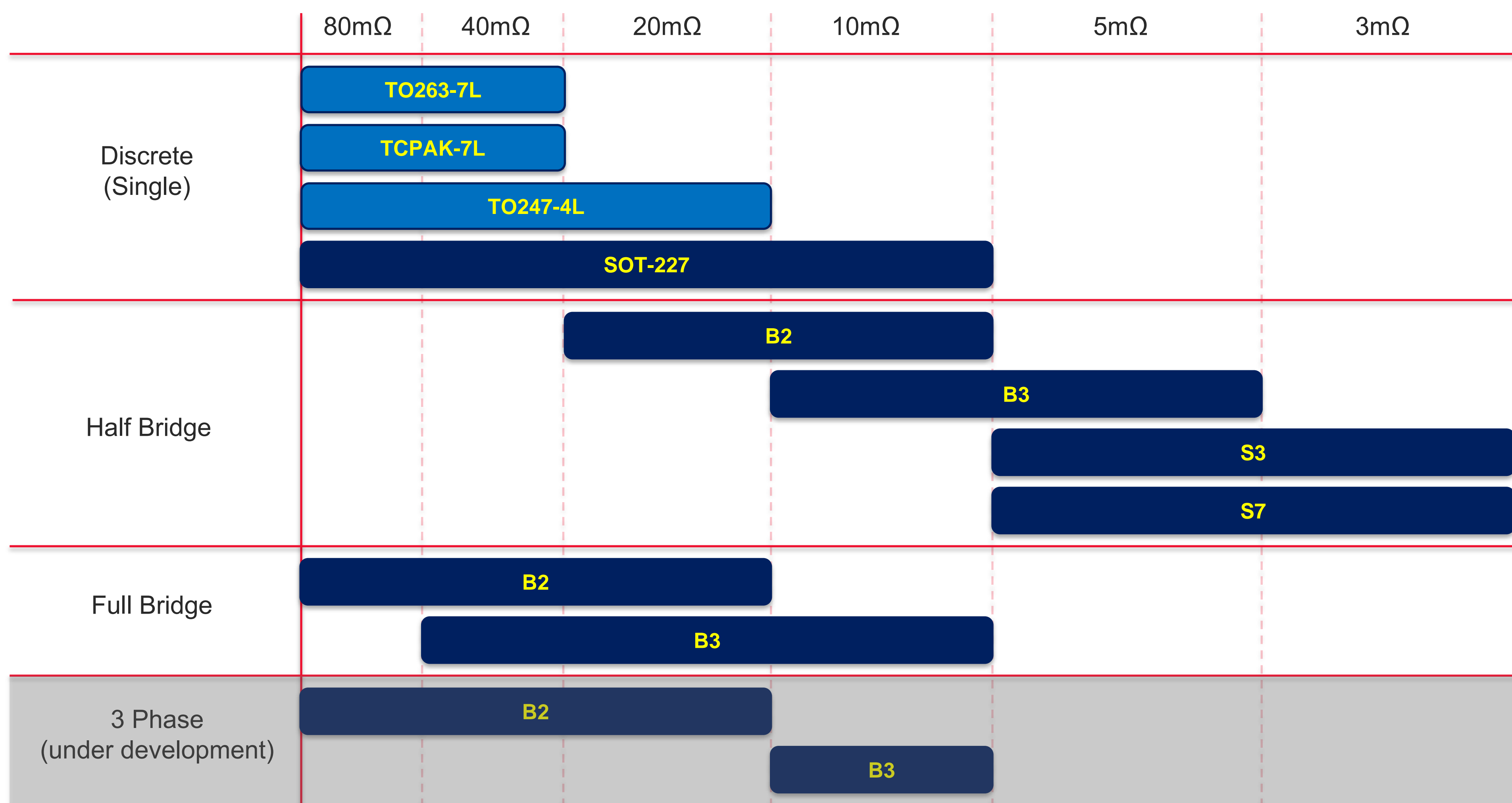


Value Proposition: SemiQ SiC Diodes



- High Breakdown Voltage
- High Surge Current Rating (10us and 10ms)
- UIS (Unclamped Inductive Switching) Testing
- Intensive Reliability Testing including over 25 Million Device Hours of High Temperature & High Reverse Bias Voltage
- Continuous Switching Operation at extended test conditions

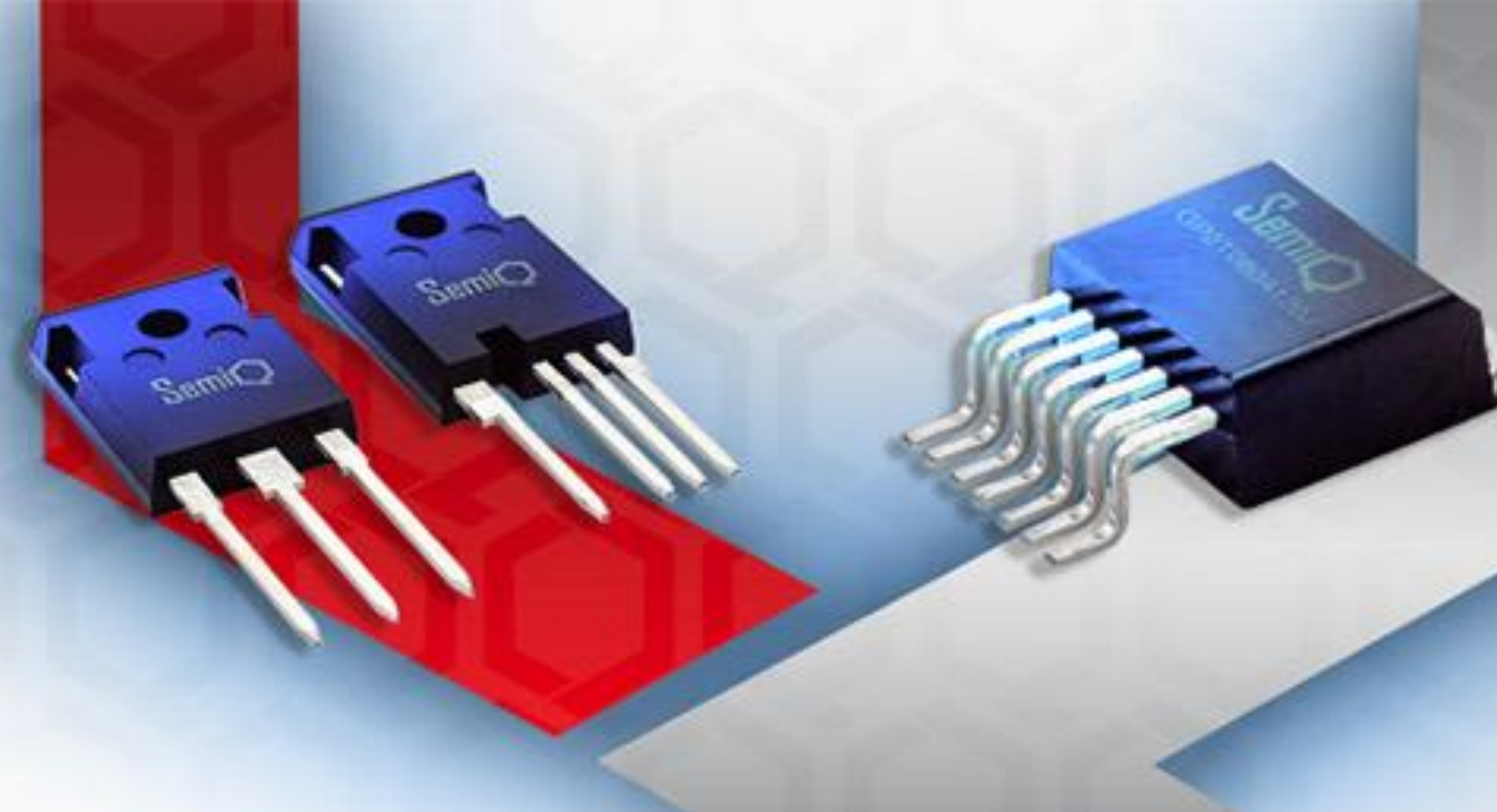
SemiQ 1200V MOSFET Product Line-up



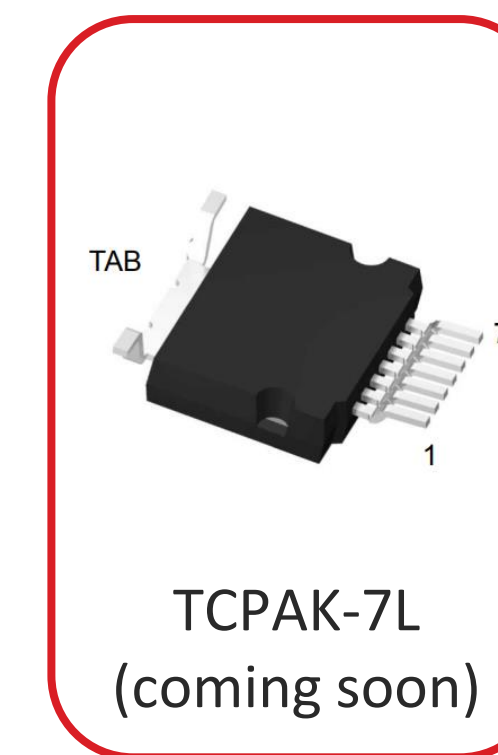
Package types

- TO263-7L 
- TCPAK-7L 
- TO247-4L 
- SOT-227 
- B2 
- B3 
- S3 
- S7 

Gen2 MOSFET Discrete



| Part Number | Voltage [V] | Rds_On mΩ | Current I _D (A) at T _C =25°C | Package |
|--------------|-------------|-----------|--|-----------|
| GP2T080A120H | 1200V | 80 | 35 | TO-247-4L |
| GP2T080A120J | | 80 | 35 | TO-263-7L |
| GP2T080A120U | | 80 | 35 | TO-247-3L |
| GP2T040A120H | | 40 | 63 | TO-247-4L |
| GP2T040A120J | | 40 | 63 | TO-263-7L |
| GP2T040A120U | | 40 | 63 | TO-247-3L |
| GP2T020A120H | | 20 | 119 | TO-247-4L |



TOP SIDE COOLING PACKAGE: TCPAK

QSiC™ 1200V SiC MOSFET

Features

- High speed switching
- Reliable body diode
- All parts tested to greater than 1,400V
- Avalanche tested to 800mJ*
- Driver source pin for gate driving

Benefits

- Top side cooling tab
- Lower capacitance
- Higher system efficiency
- Easy to parallel
- Lower Switching Loss
- Longer clearance distance

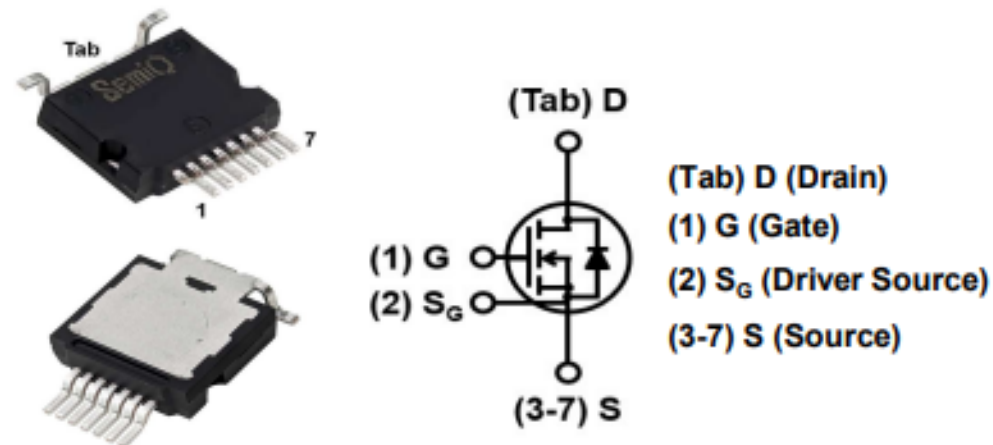
Applications

- Solar Inverters
- Switch mode power supplies, UPS
- Induction heating and welding
- EV charging stations
- High voltage DC/DC converters
- Motor drives
- Onboard charger

GP2T020A120T

| | |
|----------------|---------------|
| V_{DS} | 1200 V |
| $R_{DS,on}$ | 18 m Ω |
| I_D (TC=25C) | 129 A |
| $T_{j,max}$ | 175°C |

Package



| Part # | Package | Marking |
|--------------|---------|-----------|
| GP2T020A120T | TCPAK | 2T020A120 |

QSiC™ 1200V SiC MOSFET

Features

- High speed switching
- Reliable body diode
- All parts tested to greater than 1,400V
- Avalanche tested to 400mJ*
- Driver source pin for gate driving

Benefits

- Top side cooling tab
- Lower capacitance
- Higher system efficiency
- Easy to parallel
- Lower Switching Loss
- Longer clearance distance

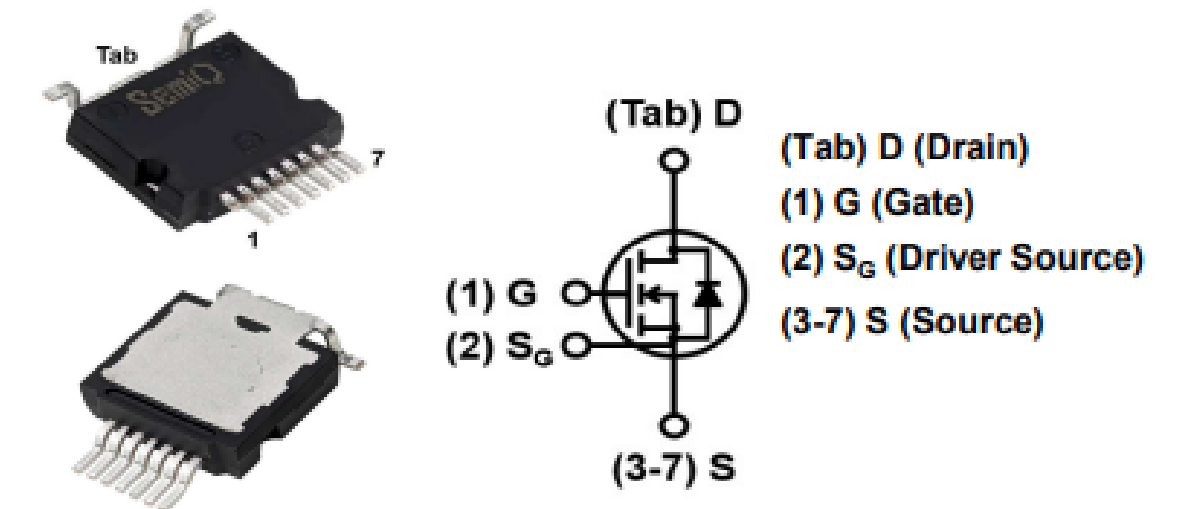
Applications

- Solar Inverters
- Switch mode power supplies, UPS
- Induction heating and welding
- EV charging stations
- High voltage DC/DC converters
- Motor drives
- Onboard charger

GP2T040A120T

| | |
|----------------|---------------|
| V_{DS} | 1200 V |
| $R_{DS,on}$ | 38 m Ω |
| I_D (TC=25C) | 66 A |
| $T_{j,max}$ | 175°C |

Package



| Part # | Package | Marking |
|--------------|---------|------------|
| GP2T040A120T | TCPAK | 2T040A120T |

Gen2 MOSFET Module – SOT-227



| Part Number | Voltage [V] | Rds_On mΩ | Current I _D (A) at T _c =25°C | Package |
|-----------------|-------------|-----------|--|-----------------|
| GCMX080A120S-E1 | 1200V | 80 | 30 | SOT-227 w/o SBD |
| GCMS080A120S-E1 | | 80 | 30 | SOT-227 w/SBD |
| GCMX040A120S-E1 | | 40 | 57 | SOT-227 w/o SBD |
| GCMS040A120S-E1 | | 40 | 57 | SOT-227 w/SBD |
| GCMX020A120S-E1 | | 20 | 113 | SOT-227 w/o SBD |
| GCMS020A120S-E1 | | 20 | 113 | SOT-227 w/SBD |
| GCMX010A120S-E1 | | 10 | 218 | SOT-227 w/o SBD |
| GCMS010A120S-E1 | | 10 | 218 | SOT-227 w/SBD |



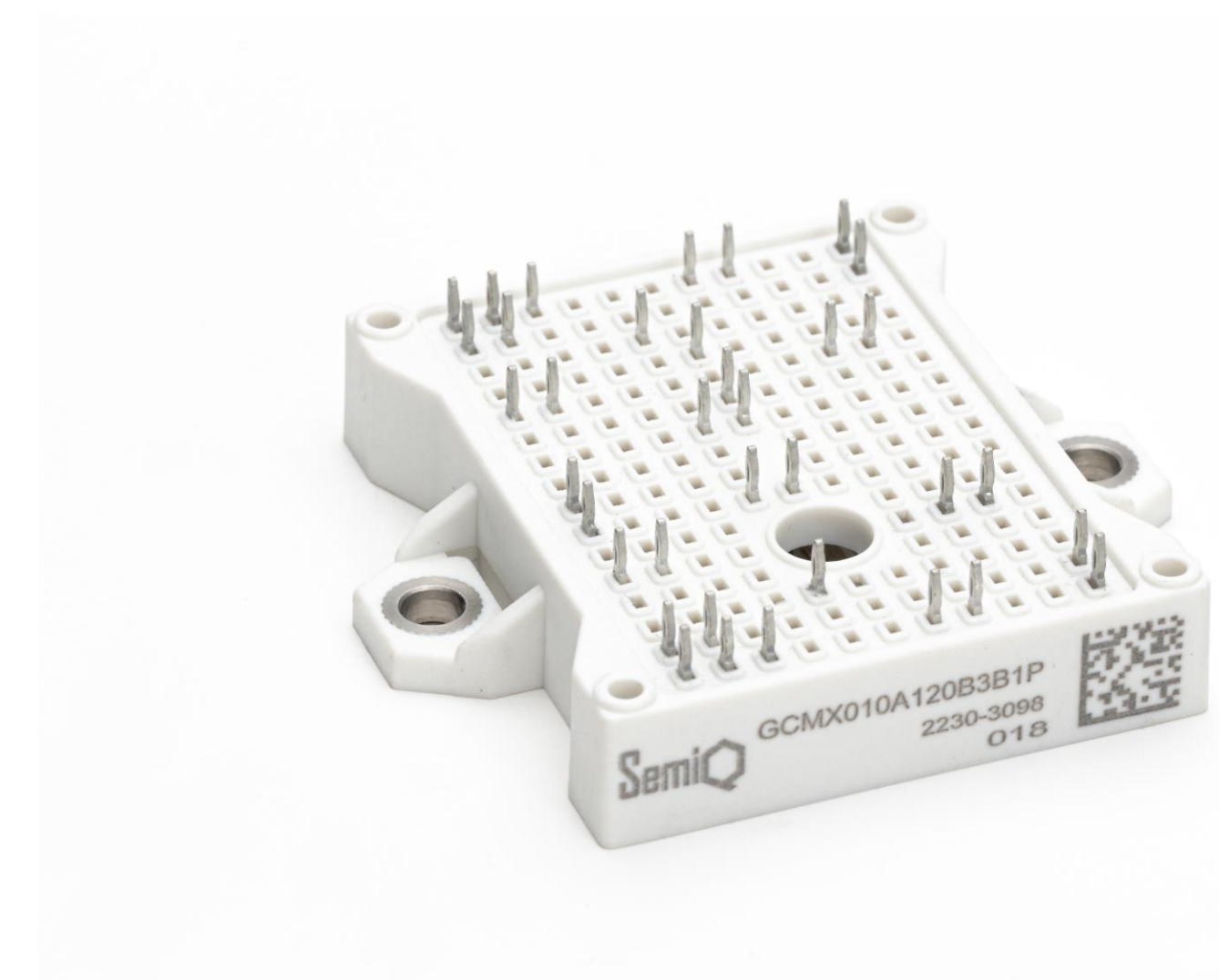
Gen2 MOSFET Module – B2 Package

| Part Number | Voltage [V] | I _D | Rds_On mOhm | Package |
|------------------|-------------|----------------|----------------|------------------|
| GCMX010A120B2B1P | 1200V | 214A | 10 | B2B1 Half Bridge |
| GCMX020A120B2B1P | | 102A | 20 | B2B1 Half Bridge |
| GCMX020A120B2H1P | | 102A | 20 | B2H1 Full Bridge |
| GCMX040A120B2H1P | | 53A | 40 | B2H1 Full Bridge |
| GCMS080A120B2H1P | | 27A | 80 | B2H1 Full Bridge |



Gen2 MOSFET Module – B3 Package

| Part Number | Voltage [V] | I _D | Rds_On mOhm | Package |
|------------------|-------------|----------------|----------------|------------------|
| GCMX005A120B3B1P | 1200V | 383A | 5 | B3B1 Half Bridge |
| GCMX010A120B3B1P | | 173A | 10 | B3B1 Half Bridge |
| GCMX010A120B3H1P | | 200A | 10 | B3H1 Full Bridge |
| GCMX020A120B3H1P | | 93A | 20 | B3H1 Full Bridge |
| GCMX040A120B3H1P | | 56A | 40 | B3H1 Full Bridge |



Gen2 MOSFET Module – S7 & S3 Package

| Part Number | Voltage [V] | I _D | Rds_On mOhm | Package |
|------------------|-------------|----------------|----------------|------------------|
| GCMX005A120S7B1 | 1200V | 348A | 5 | S7B1 Half Bridge |
| GCMX003A120S7B1 | | 450A | 3 | S7B1 Half Bridge |
| GCMX005A120S3B1* | | 348A | 5 | S3B1 Half Bridge |
| GCMX003A120S3B1* | | 450A | 3 | S3B1 Half Bridge |

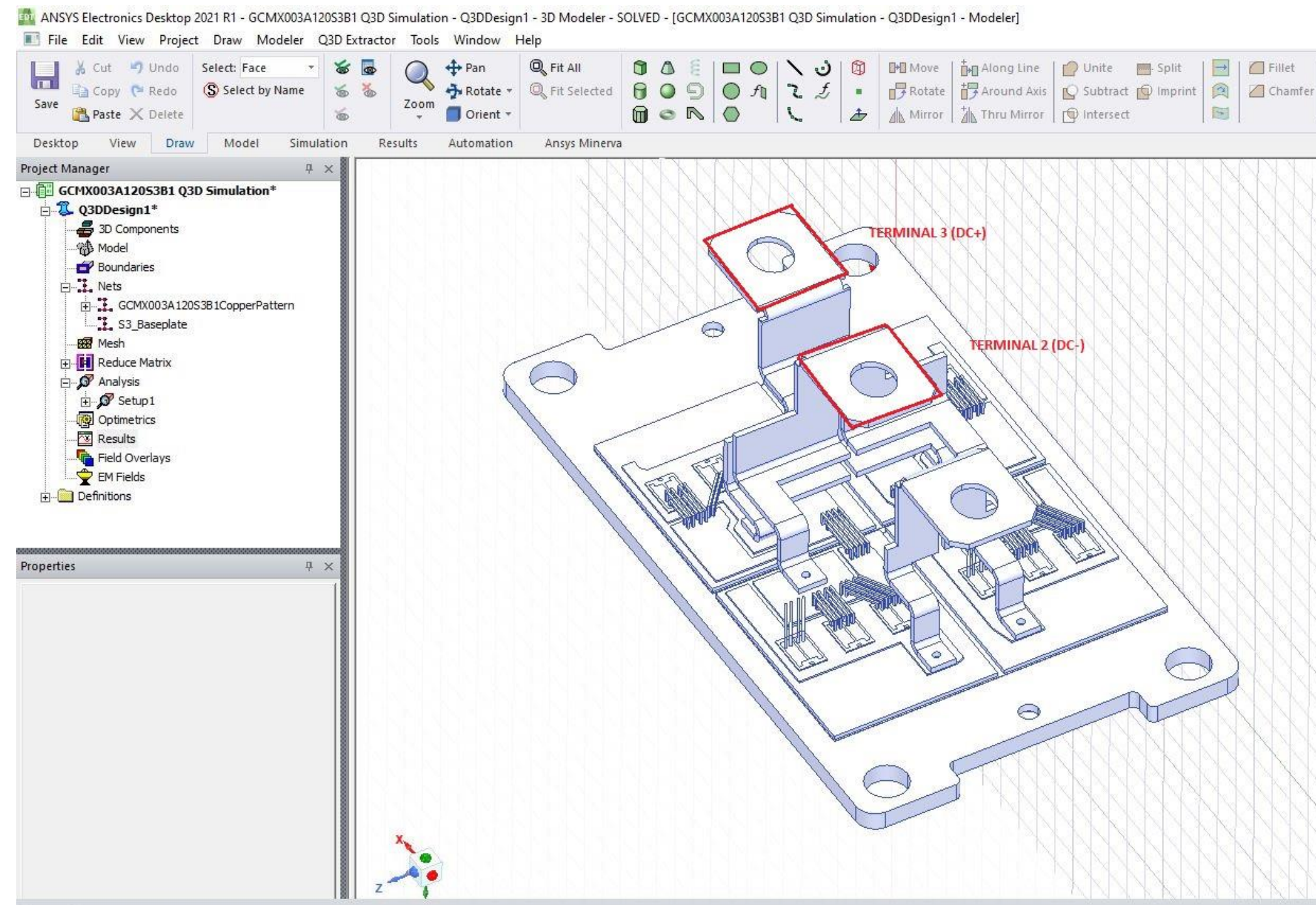
* In development



Inductances comparison of S3 and S7 packages

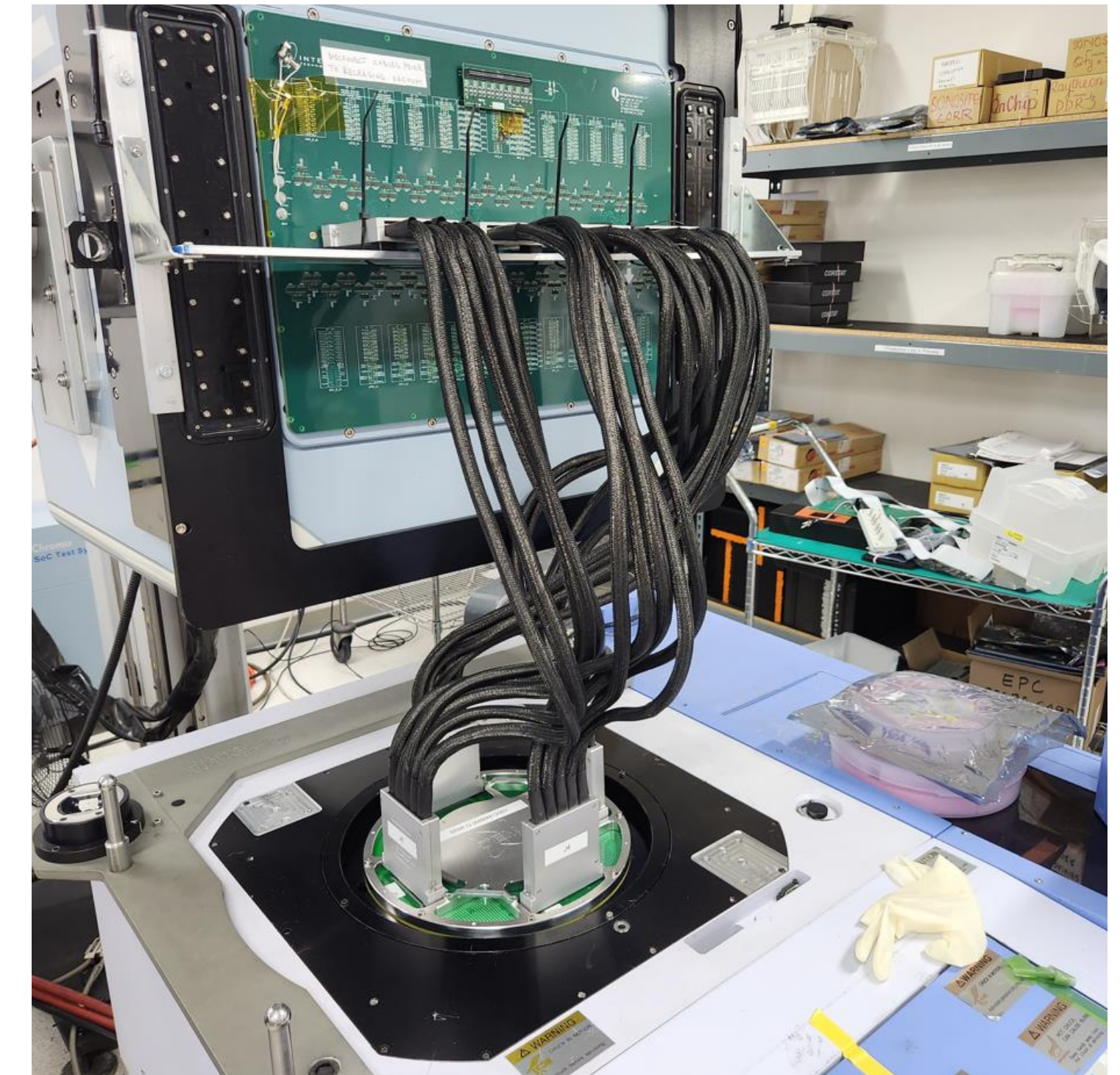
- Conditions
 - Inductance Path: Terminal 2 (DC-) to Terminal 3 (DC+)
 - Frequency Sweep from 0.01 MHz to 100 MHz

| Frequency (MHz) | 17mm S7 Inductance (nH) | 30mm S3 Inductance (nH) |
|-----------------|-------------------------|-------------------------|
| 0.01 | 11.71 | 15.95 |
| 0.02 | 10.46 | 14.88 |
| 0.05 | 9.29 | 13.85 |
| 0.1 | 8.69 | 13.31 |
| 0.2 | 8.26 | 12.92 |
| 0.5 | 7.87 | 12.57 |
| 1 | 7.68 | 12.40 |
| 2 | 7.54 | 12.27 |
| 5 | 7.42 | 12.16 |
| 10 | 7.36 | 12.11 |
| 20 | 7.31 | 12.07 |
| 50 | 7.28 | 12.03 |
| 100 | 7.26 | 12.02 |

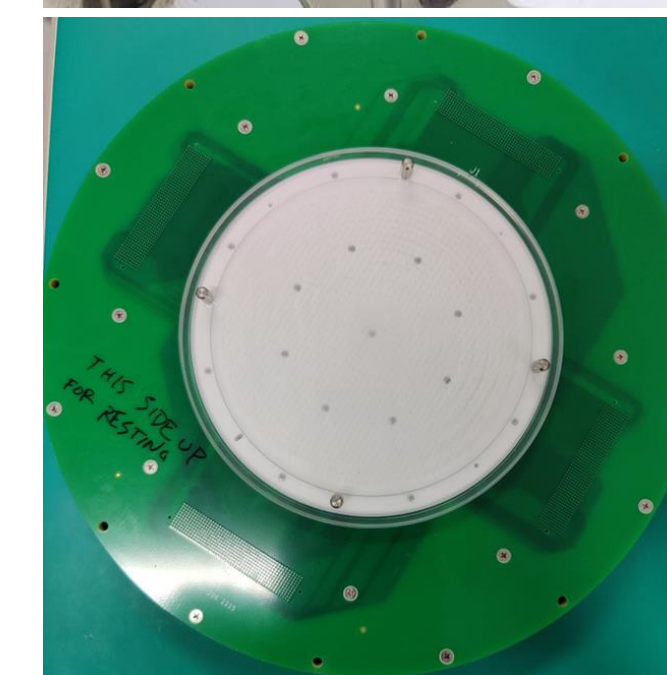


100% Wafer Level Gate Burn-In Testing on MOSFETs

- Proprietary wafer level burn-in testing at high temperature and at high gate voltage.
- Improve the assembly and production yield of power modules with known good dies.
- Screen out the weak gate devices: Suitable for high quality system applications including fast EV charging, solar inverter, and automotive on board charger and traction inverter.



| Part Number | Voltage [V] | Rds_On mOhm | Package |
|--------------|-------------|----------------|----------|
| GP2T080A120X | 1200V | 80 | Bare Die |
| GP2T040A120X | | 40 | Bare Die |
| GP2T020A120X | | 20 | Bare Die |



Value Proposition: SemiQ SiC MOSFET

- High Breakdown Voltage
- Tested at avalanche breakdown (UIL testing)
- High Quality Gate Oxide with Stable Gate Threshold Voltage
- No Body Diode Degradation
- Reliable Short Circuit Rating
- Continuous Switching Operation at Extended Test Conditions
- Reliability tested to exceed JEDEC quality standard
- Aluminum Nitride substrate (ALN) – (SOT-227 and S3 packages)

SemiQ Reliability Test Specifications



| Test | Conditions | Lots | Total Samples | Failed Devices | Standards |
|---|--|------|---------------|----------------|----------------|
| Electrical Parameter Assessment | Datasheet Items | 3 | 75 | 0 | JESD86 |
| High Temperature Reverse Bias (HTRB) | V_R =Max Reverse Voltage, $T_{amb} = 175\text{ °C}$, 1000 hrs | 3 | 240 | 0 | JESD22-A108 |
| High Temperature Gate Bias (HTGB) | V_{gs} =+25V/-10V, $T_{amb} = 175\text{ °C}$, 1000 hrs | 3 | 240 | 0 | JESD22-A108 |
| High Humidity High Temperature Reverse Bias (H3TRB) | 85 °C, 85% R.H., $V_R=100\text{ V}$, 1000 hrs | 3 | 240 | 0 | JESD22-A101 |
| Temperature Cycling (TC) | -55 °C to +150 °C, 2 cycles/hr, 1000 cycles | 3 | 240 | 0 | JESD22-A104 |
| Unbiased Highly Accelerated Stress Test (UHAST) | 131 °C, 85% R.H., 33 PSIA, 96 hrs | 3 | 240 | 0 | JESD22-A102 |
| High Temperature Storage Life (HTSL) | $T_{amb} = 175\text{ °C}$, 1000 hrs | 3 | 240 | 0 | JESD22-A103 |
| Intermittent Operating Life (IOL) | $\Delta T_j \geq 125\text{ °C}$, 3000 cycles 5 mins on/off | 3 | 240 | 0 | MIL-STD-750 |
| Electrostatic Discharge | HBM and CDM, $T_{amb} = 25\text{ °C}$ | 3 | 15 | 0 | JS-001, JS-002 |

SemiQ | www.semiq.com/

Technology Partner



800.348.5580
630.208.2200



rellpower.com
rellpower@rell.com

AEC-Q101 Qualification Tests



| Item # | Stress | Lots | Samples per Lot |
|--------|--------------------------------|------|------------------------------|
| 1 | External Visual | 3 | All |
| 2 | Parametric Verification | 3 | 25 |
| 3 | HTRB | 3 | 80 |
| 4 | HTGB (+25V, -10V) | 3 | 80 |
| 5 | Temperature Cycling | 3 | 80 |
| 6 | UHASt | 3 | 80 |
| 7 | H3TRB | 3 | 80 |
| 8 | IOL | 3 | 80 |
| 9 | Destructive Physical Analysis | 1 | 2 |
| 10 | ESD (HBM) | 1 | 30 |
| 11 | ESD (CDM) | 1 | 30 |
| 12 | Unclamped Inductive Switching | 1 | 5 |
| 13 | Short Circuit Characterization | 3 | 10 |
| 14 | Physical Dimension | 1 | 30 |
| 15 | Terminal Strength | 1 | 30 |
| 16 | Resistance to Solder Heat | 1 | 30 |
| 17 | Solderability | 1 | 10 |
| 18 | Thermal Resistance | 1 | 10 |
| 19 | Wire Bond Strength | 1 | 10 bonds from min of 5 parts |
| 20 | Bond Shear | 1 | 10 bonds from min of 5 parts |
| 21 | Die Shear | 1 | 5 |
| 22 | Dielectric Integrity | 1 | 5 |
| 23 | TCHT | 3 | 5 |

SemiQ | www.semiq.com/

Technology Partner



800.348.5580
630.208.2200



rellpower.com
rellpower@rell.com



Technology Partner

**Richardson
Electronics**

POWER & MICROWAVE
TECHNOLOGIES



800.348.5580 | 630.208.2200



rellpower.com | rellpower@rell.com
rellpower.com/locations

For over 75 years, Richardson Electronics has been your industry-leading global provider of engineered solutions. We are an authorized distributor that provides specialized technical expertise and engineered solutions based on our core engineering and manufacturing capabilities. We provide solutions and add value through design-in support, systems integration, prototype design and manufacturing, testing, logistics, and aftermarket technical service and repair-all through our existing global infrastructure.

We are proud to announce our new partnerships with manufacturers of leading edge and disruptive technologies. These technologies drive the latest innovations for our customers.