A Leading Provider of Smart, Connected and Secure Embedded Control Solutions
Many Suppliers ...
JUST ANOTHER SiC SUPPLIER?
Technical Advantages?

Example: MSC040SMA120B4
What Is Important for You?

- Technical parameters (low losses, Rth, Kelvin Pin ...)
- Reliability
- Quality and FA
- Support
- Availability
- Longevity
- Time to Market (TTM)
- Cost
- Less risk
- Other factors
# SiC Products Overview

<table>
<thead>
<tr>
<th>Product Family</th>
<th>Product Packages</th>
<th>Sub Product Family</th>
<th>Key Differentiation</th>
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</thead>
<tbody>
<tr>
<td><strong>Power Discretes</strong></td>
<td>• SiC die</td>
<td>• One of the broadest portfolios on the market</td>
<td>• QSS (Quality, Supply, Support)</td>
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<tr>
<td></td>
<td>• Discrete SiC MOSFETs</td>
<td></td>
<td>• 30+ years in dev, design and support of power discretes</td>
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<td></td>
<td>• Discrete SBDs (Schottky Barrier Diodes)</td>
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<tr>
<td><strong>Power Modules</strong></td>
<td>• SiC MOSFET power modules</td>
<td>• Standard packages and architectures available</td>
<td>• Flight-proven heritage on both Boeing and Airbus platforms</td>
</tr>
<tr>
<td></td>
<td>• SiC Diode power modules</td>
<td></td>
<td>• Proven reliability in critical applications</td>
</tr>
<tr>
<td><strong>Integrated Power</strong></td>
<td>• Power Control Module (PCM), Hybrid Power Drive Modules</td>
<td>• Highest level of integration and reliability for</td>
<td>• Standard SiC solution available as well semi-custom SiC and IGBT offerings available</td>
</tr>
<tr>
<td>Solutions</td>
<td>(HPD/HPE)</td>
<td>flight-critical applications</td>
<td>• Partial discharge, current monitoring, over voltage, solenoid drive, short circuit protection, digital</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>interface for control, screw and solder options</td>
</tr>
</tbody>
</table>

- **Power Discretes**
  - SiC die
  - Discrete SiC MOSFETs
  - Discrete SBDs (Schottky Barrier Diodes)
  - One of the broadest portfolios on the market
  - QSS (Quality, Supply, Support)
  - 30+ years in dev, design and support of power discretes

- **Power Modules**
  - SiC MOSFET power modules
  - SiC Diode power modules
  - Standard packages and architectures available
  - Flight-proven heritage on both Boeing and Airbus platforms
  - Proven reliability in critical applications
  - High design flexibility

- **Integrated Power Solutions**
  - Power Control Module (PCM), Hybrid Power Drive Modules (HPD/HPE)
  - Highest level of integration and reliability for flight-critical applications
  - Standard SiC solution available as well semi-custom SiC and IGBT offerings available
  - Partial discharge, current monitoring, over voltage, solenoid drive, short circuit protection, digital interface for control, screw and solder options
The Whole Power Circuit

Analog Solutions

- DC/DC Converters
- PWM Controllers
- Battery Chargers
- Power Modules
- Power MOSFET Drivers
- Power MOSFETs

Digital Control

- Motor Drivers
- System Supervisors
- Voltage Detectors
- Power Switches
- Hot Swap
- Power Controllers
- DDR & SCSI Terminators
- Display/LED Drivers

Intelligent Analog / Hybrid

- PIC16F17xx – CIP/Hybrid
- MCP19xxx - DEPA

POWER STAGE

SWITCHES/DiodeS/MODULES

HIGH VOLTAGE

www.microchip.com/treelink

www.microchip.com/smps

www.microchip.com/SiC
Hardware Solutions

Microcontrollers

RFICs MMICS

Digital Potentiometer

Sensors

Amplifiers

Voice & Audio Processing

Filters

Touch Sensing
- Proximity/3D
- Buttons/Slider
- Touch Screen

Timing
- Clocks
- Timers
- RTCC

Memory
- EEPROM
- Serial Flash
- Serial SRAM

A/D

Encryption & Security

Power Management

DC-DC Converters
Supervisors & Ref.
LDGs, Battery Mgt.
Discretes & Modules

Motor Drivers

Power Drivers

D/A

LED Drivers

Smoke Detector
& Piezoelectric
Horn Drivers

High Voltage I/Os

FPGA/ SoCs

RFICs

MMICs

Wireless
- Wi-Fi®
- Bluetooth®
- LoRa®
- ZigBee®/MiWi™

Ethernet
- Switches
- Controllers
- EtherCAT
- PHYs
- PoE

Optical Networking

Storage
- PCIe® Switches
- Adapters
- Controllers

USB
- Smart Hubs
- Switches
- Transceivers
- Bridges

Auto/Industrial Communication
- MOST®
- INICnet™
- RS232/485
- CAN/LIN

Voice & Audio Processing

Memory
- EEPROM
- Serial Flash
- Serial SRAM

Wireless
- Wi-Fi®
- Bluetooth®
- LoRa®
- ZigBee®/MiWi™

Ethernet
- Switches
- Controllers
- EtherCAT
- PHYs
- PoE
DC/DC Converter Example (TSS)

- **Vdc**: Input voltage for the system.
- **Boost Stage**: SiC MOSFETs with MOSFET Driver.
- **LLC half-bridge**: SiC MOSFETs with MOSFET Driver and Pre-Driver TC4427A.
- **SR rectifier**: SiC MOSFETs with Pre-Driver TC4427A.
- **SiC MOSFETs**
- **MOSFET Driver**: Components for driving MOSFETs.
- **Pre-Driver TC4427A**: Additional driver for high efficiency.
- **dsPIC33**: Main controller in the system.
- **Temp Sensor MCP9700**: Temperature monitoring component.
- **CAN MCP25xx**: Communication interface.
- **LDO MCP1755**: Low-dropout regulator for stable 3.3V output.
- **Regulator MCP16311**: Voltage regulator component.
- **DC/DC LX7309**: DC-DC converter for input voltage regulation.

Components such as SiC MOSFETs and regulators are crucial for high efficiency and reliability in DC/DC conversion systems.
Acquisition of AgileSwitch

Optimize with a Keystroke

New Intelligent Configuration Tool for Driving SiC MOSFETs

Field-Tested Production Gate Drivers

Stop Burning Up Gate Driver Boards

agileswitch.com
Support Examples

- **Tools**
  - MPLAB® X IDE
  - MPLAB® XC Compiler
  - MPLAB® Code Configurator (MCC)
  - MCC SMPS Library
  - Digital Compensator Design Tool (DCDT)
  - MPLAB® Mindi™ Analog Simulator
  - Demos/RefDesigns

- **Help**
  - POWER-CHECK
  - Local Experts
  - 24/7 Support
  - Power - Partners
  - And more ...
Power Stage (SiC) Offering

(DISCRETES & MODULES)
## SiC SBD/MOSFET Product Releases

### SiC Schottky Barrier Diodes (SBDs)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>$I_{F(max)}$</th>
<th>$V_F$</th>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>700 V</td>
<td>10 A</td>
<td>1.5 V</td>
<td>MSC010SDA070B/Die</td>
<td>MSC010SDA070K/TO-247</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MSC010SDA070B/TO-220</td>
<td>MSC010SDA070B/TO-247</td>
</tr>
<tr>
<td>50 A</td>
<td>1.5 V</td>
<td></td>
<td>MSC005SDA120B/Die</td>
<td>MSC005SDA120B/TO-247</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MSC005SDA120B/TO-220</td>
<td>MSC005SDA120B/TO-247</td>
</tr>
<tr>
<td>15 A</td>
<td>1.5 V</td>
<td></td>
<td>MSC003SDA170B/Die</td>
<td>MSC003SDA170B/TO-247</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MSC003SDA170B/TO-220</td>
<td>MSC003SDA170B/TO-247</td>
</tr>
</tbody>
</table>

### SiC MOSFETs

<table>
<thead>
<tr>
<th>Voltage</th>
<th>$R_{DS(On)}$</th>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>700 V</td>
<td>90 mΩ</td>
<td>MSC090SDA070B/Die</td>
<td>MSC090SDA070B/TO-247</td>
</tr>
<tr>
<td></td>
<td>60 mΩ</td>
<td>MSC060SDA070B/Die</td>
<td>MSC060SDA070B/TO-247</td>
</tr>
<tr>
<td></td>
<td>35 mΩ</td>
<td>MSC035SDA070B/Die</td>
<td>MSC035SDA070B/TO-247</td>
</tr>
<tr>
<td></td>
<td>15 mΩ</td>
<td>MSC015SDA070B/Die</td>
<td>MSC015SDA070B/TO-247</td>
</tr>
<tr>
<td>1200 V</td>
<td>80 mΩ</td>
<td>MSC080SDA120B/Die</td>
<td>MSC080SDA120B/TO-247</td>
</tr>
<tr>
<td></td>
<td>40 mΩ</td>
<td>MSC040SDA120B/Die</td>
<td>MSC040SDA120B/TO-247</td>
</tr>
<tr>
<td></td>
<td>25 mΩ</td>
<td>MSC025SDA120B/Die</td>
<td>MSC025SDA120B/TO-247</td>
</tr>
<tr>
<td>1700 V</td>
<td>750 mΩ</td>
<td>MSC750SDA170B/Die</td>
<td>MSC750SDA170B/TO-247</td>
</tr>
<tr>
<td></td>
<td>45 mΩ</td>
<td>MSC045SDA170B/Die</td>
<td>MSC045SDA170B/TO-247</td>
</tr>
</tbody>
</table>
SiC Value Proposition

- **Quality**: Proven reliability and ruggedness
- **Supply**: Risk averse approach throughout the supply chain
- **Support**: Standard and custom die, discrete and module options for small to large customers

Microchip SiC Solutions
SiC Value Proposition

Quality: Proven Reliability and Ruggedness

- Two major metrics for comparison
  - Average time to breakdown
  - Dispersion of the lifetime distribution

- Microsemi’s robust next generation 1200 V, 40 mΩ SiC MOSFET
  - Excellent gate oxide shielding and channel integrity
  - No gate oxide lifetime degradation even after 100 K RUIS

SiC MOSFET RUIS-TDDB Gate Oxide Stress Tests

The TDDB test condition is constant current 50 uA @ room temperature
Power Modules

- **Power Modules**
  - D3: up to 50 kHz
  - D4: up to 50 kHz
  - SP6, SP6LI, SP6P: STANDARD MODULES
  - SP4: MODIFIED STANDARD MODULES
  - SP3F, SP2, SP1, SOT227: CUSTOM MODULES

- **Current @ Tc=80°C**
  - 10, 50, 100, 200, 400, 600, 800 (A)

- **Voltage**
  - 600 V
  - 1200 V
  - 1700 V
  - IGBT
  - SiC

- **SiC Devices**
  - 75 V - 1700 V
  - IGBT
  - MOSFET
  - FRED
  - SiC
Power Module Architecture

**Power semiconductor die**
- IGBT, Mosfet, Diode, SiC
  - Soldered to the substrates
  - Connected by ultrasonic Al wire bonds

**Substrates**
- Al2O3, AlN, Si3N4
  - Provide isolation
  - Good heat transfer to the base plate

**Base plate**
- Improve the heat transfer to the heatsink
  - Copper material for good thermal transfer
  - AlSiC for improved reliability

**Terminals**
- Screw on or solder pins
  - Provide the user with power and signal connections
  - Minimum parasitic resistance and inductance

**Package**
- Standard or custom
  - Environmental protection
  - Mechanical robustness

**Internal printed circuit board**
- Not available in all modules.
  - Used to route gate signals tracks to small signal terminals
  - Used to mount gate circuit and protection in case of intelligent power module

Heart of the power module
Offering wide tradeoff in price, performance and reliability
## SP6LI Module Products

<table>
<thead>
<tr>
<th>PN</th>
<th>Voltage</th>
<th>Current</th>
<th>RDSon Typ</th>
<th>RDSon max.</th>
<th>SiC parallel diode ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSCMC120AM07CT6LIAG</td>
<td>1200V</td>
<td>210 A</td>
<td>6.7 mΩ</td>
<td>9.2 mΩ</td>
<td>100A</td>
</tr>
<tr>
<td>MSCMC120AM04CT6LIAG</td>
<td>1200V</td>
<td>307 A</td>
<td>4.2 mΩ</td>
<td>5.6 mΩ</td>
<td>200 A</td>
</tr>
<tr>
<td>MSCMC120AM03CT6LIAG</td>
<td>1200V</td>
<td>475 A</td>
<td>2.5 mΩ</td>
<td>3.4 mΩ</td>
<td>250 A</td>
</tr>
<tr>
<td>MSCMC120AM02CT6LIAG</td>
<td>1200V</td>
<td>586 A</td>
<td>2.1 mΩ</td>
<td>2.8 mΩ</td>
<td>300 A</td>
</tr>
<tr>
<td>MSCMC170AM08CT6LIAG</td>
<td>1700V</td>
<td>207 A</td>
<td>7.5 mΩ</td>
<td>11.7 mΩ</td>
<td>200 A</td>
</tr>
</tbody>
</table>

- Excellent coupling between VBUS and 0/VBUS bus bars
- Parasitic loop inductance measured at very low 2.9nH
- Full screw terminals inter-connection for signal and power
- SP6 package Industrial standard 62 mm x 108 mm footprint
- Phase leg configuration
- AlN or Si3N4 substrate with copper or AlSiC baseplate and NTC monitoring
- Module phase legs are easy to parallel and connection to DC bus is achieved without parasitic inductance
- Possibility to interconnect 3 modules together in vertical or horizontal position
SiC Reference Designs

- 700 V and 1200 V SiC SBD/MOSFET SPICE models available

MSCSICSP6/REF3: SiC SP6LI driver module
- https://www.microsemi.com/existing-parts/parts/147054

MCSICSP3/REF2: SiC SP3 driver module
- https://www.microsemi.com/existing-parts/parts/146951

MCSICPFC/REF5: 30 kW PFC ref. design
- https://www.microsemi.com/existing-parts/parts/146951
- APEC 2019 YouTube Video

Vienna Rectifier 30kW 3phase PFC

Gate Driver Reference Designs
## SiC Power Discrete and Module

<table>
<thead>
<tr>
<th>Year</th>
<th>Gen 1 SiC MOSFET</th>
<th>Next Gen SiC MOSFET Commercial</th>
<th>Gen 1 SiC SBD</th>
<th>Next Gen SiC SBD Commercial</th>
<th>SiC Power Module: 650-700/1200/1700+ V D3, SP1, SP3F, SP6P, SP6LI</th>
<th>AQG 324 in CY 2020 on SP6LI or similar</th>
<th>New discrete packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>700 V/1200 V, 35-140 mΩ</td>
<td>700 V 1200 V 1700 V xxxxx 15-90 mΩ 25-360 mΩ, 45-750 mΩ 35-400 mΩ</td>
<td>700 V 1200 V 1700 V xxxxx 15-90 mΩ 25-80 mΩ</td>
<td>700 V 1200 V 1700 V xxxxx 10-50 A 10-50 A 10-50 A 5-20 A</td>
<td>650-700/1200/1700+ V D3, SP1, SP3F, SP6P, SP6LI</td>
<td>AQG 324 in CY 2020 on SP6LI or similar</td>
<td>TO-247-4L D2/D3PAK-7L, client SMT needs</td>
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<tr>
<td>2017</td>
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<td>202X</td>
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Roadmap is a product timeline guide and subject to change without notice.
Thank You