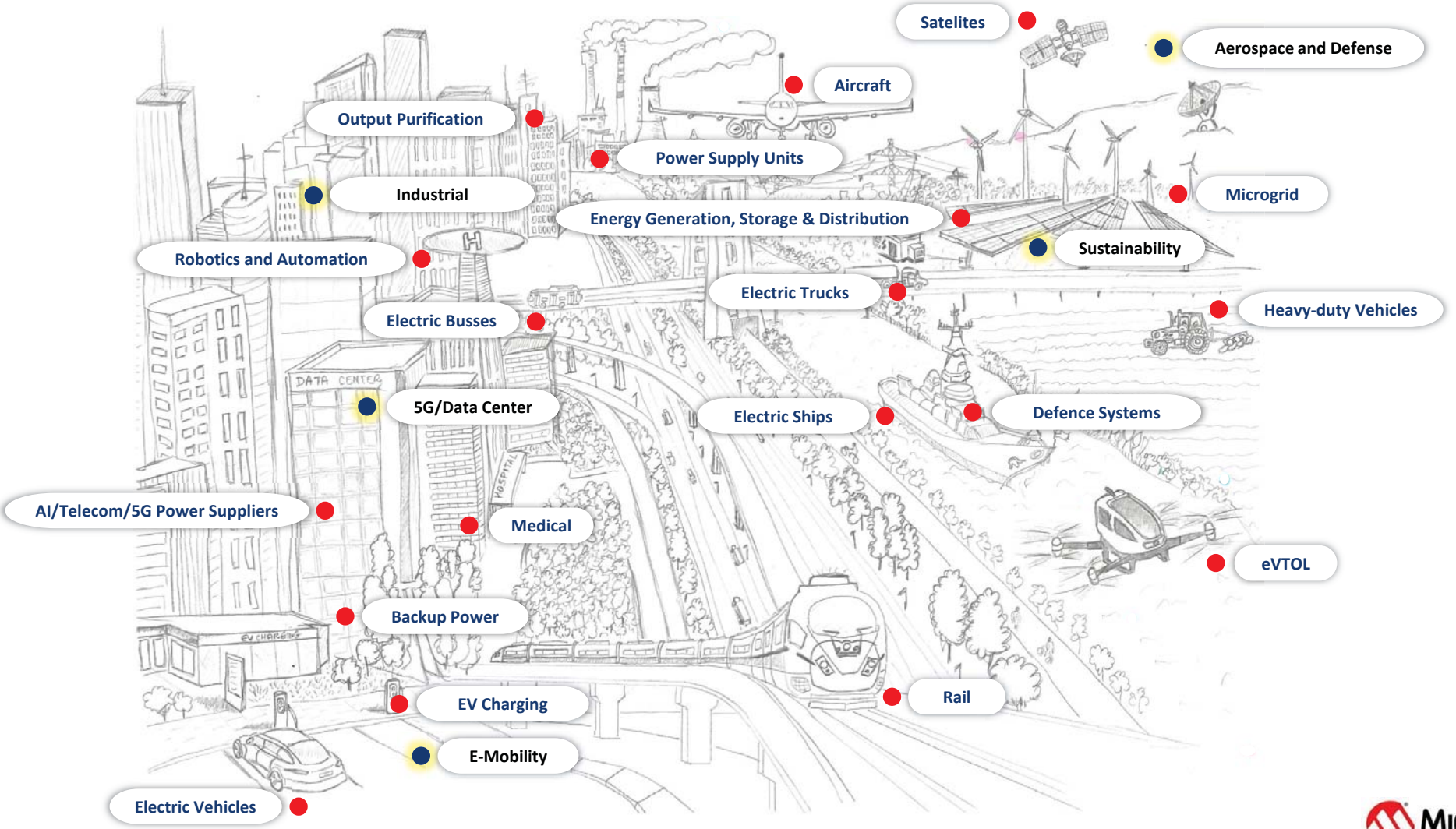
The Next Wave of SiC Packaging and mSiC™ Products

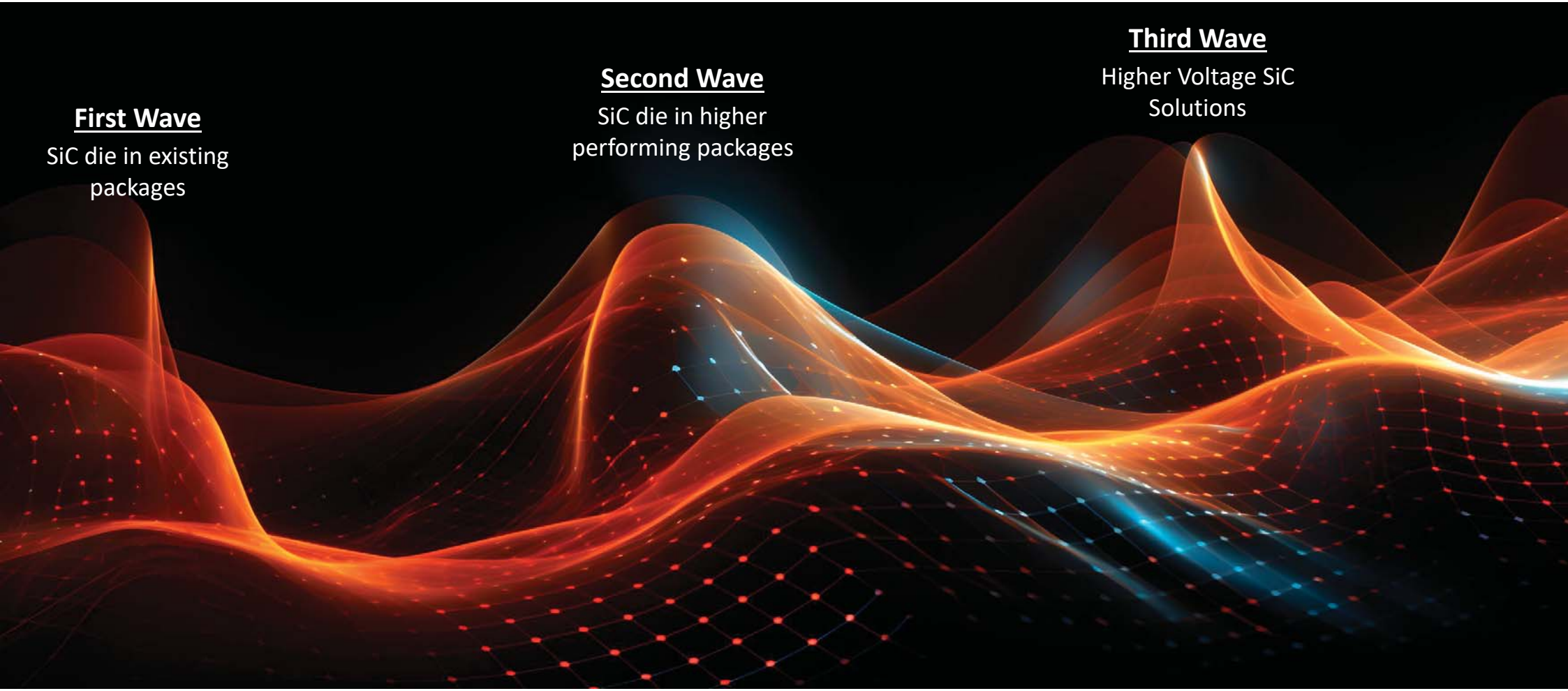
Jason Chiang
jason.chiang@microchip.com
Marketing Solutions | SiC BU

MICROCHIP

The Electrification of Everything



Riding the Second Wave of Silicon Carbide (SiC)

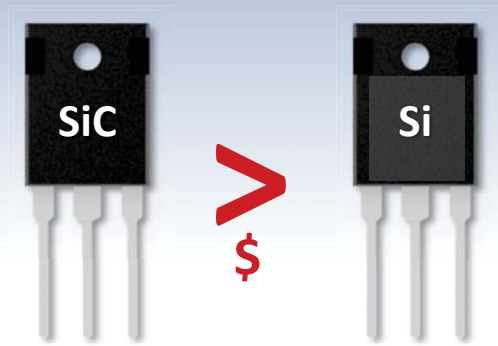


MICROCHIP

The Move from Si to SiC Devices

Narrow view

SiC more expensive than silicon



Big picture view

SiC systems can be less expensive than silicon, PLUS…

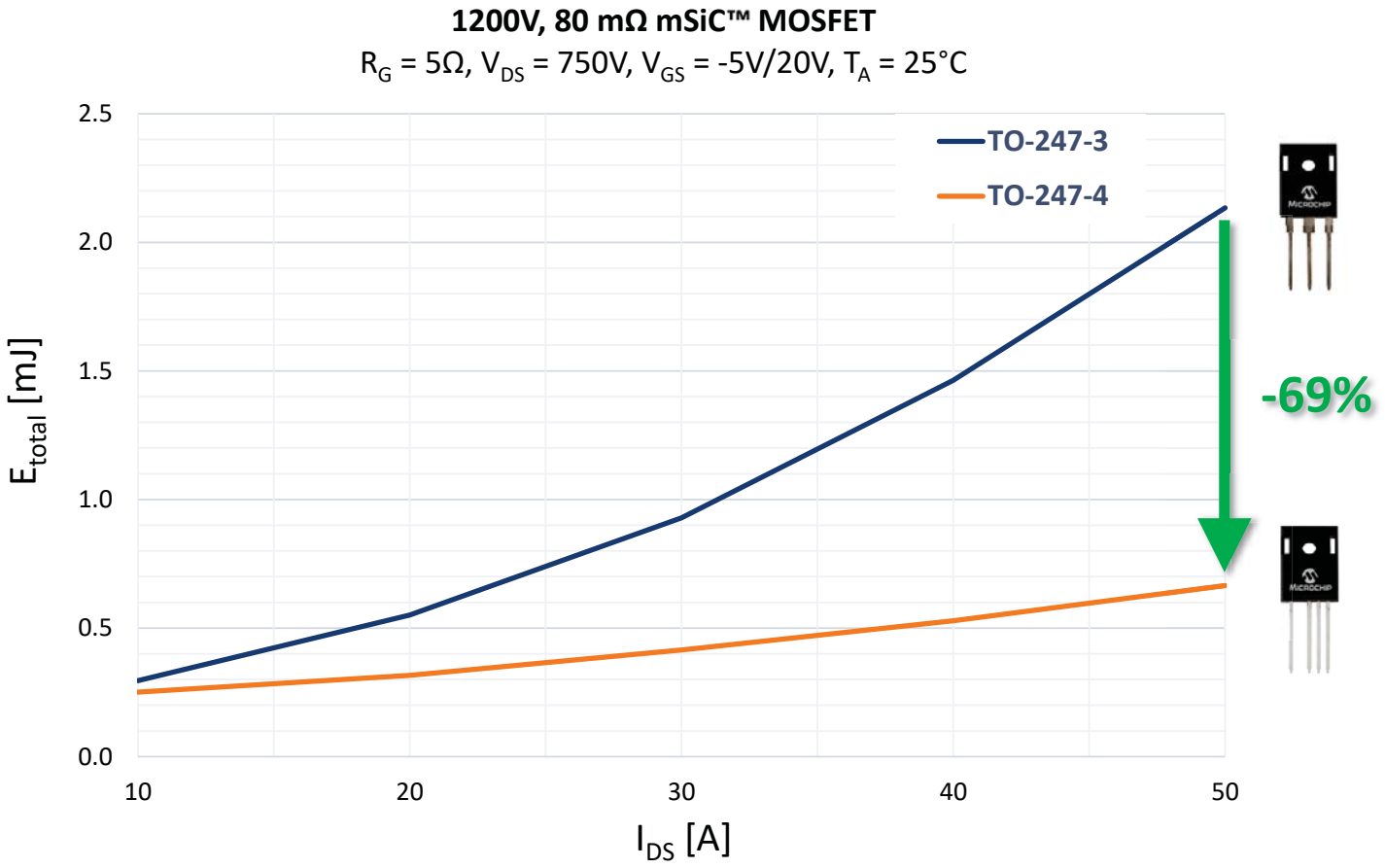
In addition to cutting their cost, SiC can make systems:

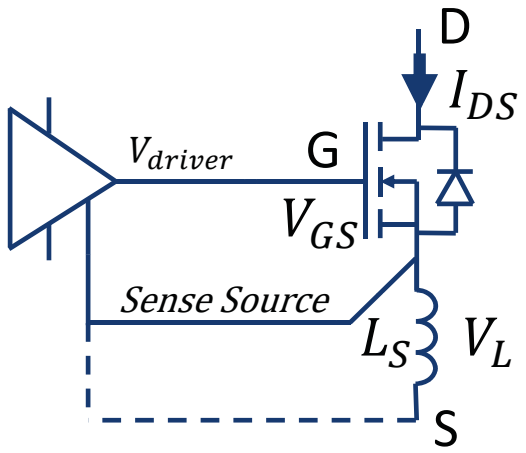
- More efficient
- Last longer
- More rugged
- Smaller and lighter

MICROCHIP

TO-247 Performance Improvement

Source sense pin for faster turn on and lower switching losses



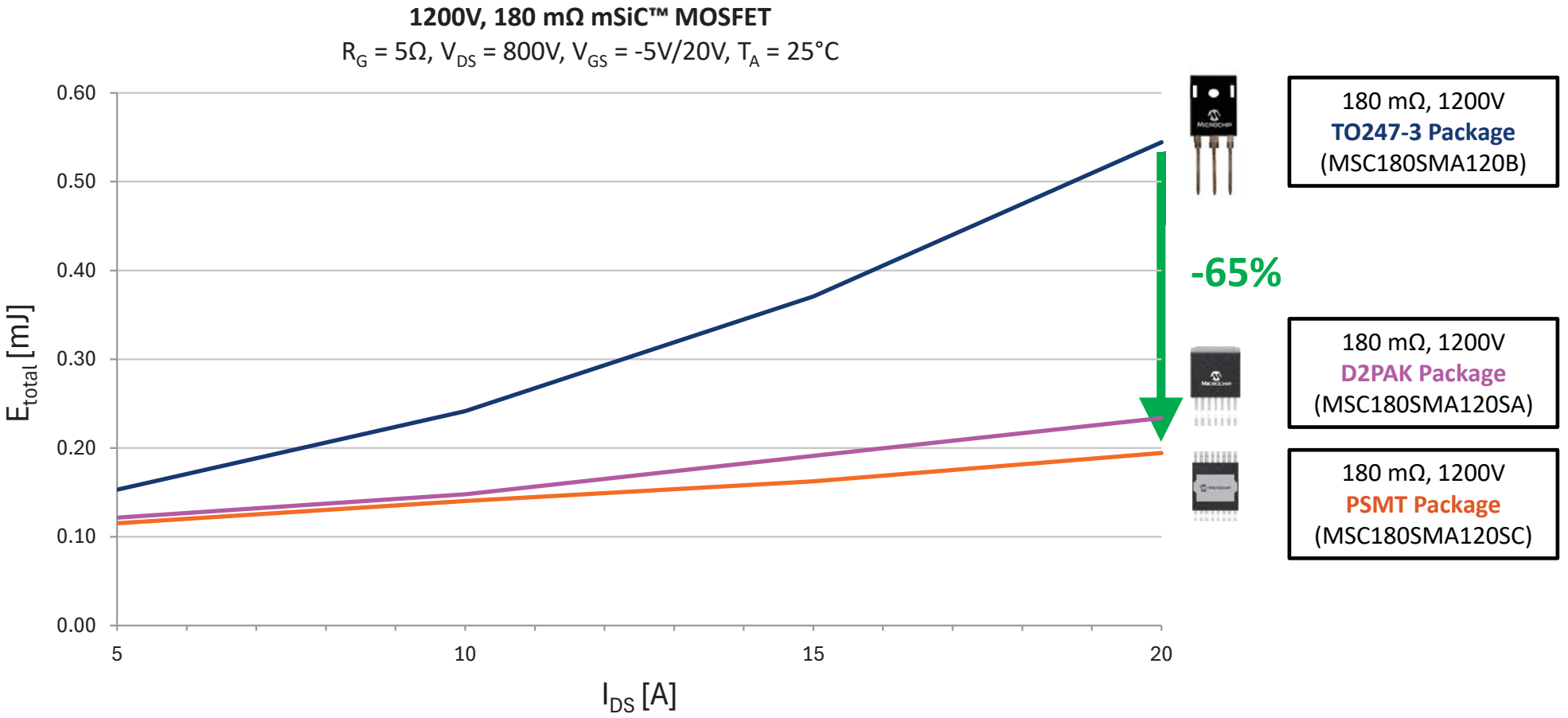


$$V_{GS} = V_{driver} - L_s \frac{dI_{DS}}{dt}$$

$$V_{GS} = V_{driver} - V_L$$

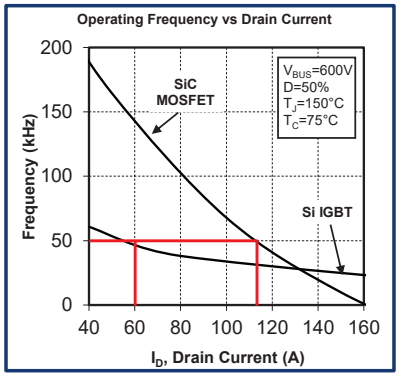
Pushing Beyond The TO-247 with SMT Packages

Source sense pins and top-side cooled



SiC Power Modules For Even Higher Density

Parameter	Microchip APTGLQ300A120G	Microchip MSCSM120AM16CT1AG	Comparison SiC vs Si
Semiconductor type	**Trench4 Fast IGBT**	**mSiC™ MOSFET**	
Ratings @ T_c = 25°C	**500A / 1200V**	**173A / 1200V**	
Package type	**SP6C (108 x 62 mm)**	**SP1F (52 x 41 mm)**	**~3.0 x smaller**
Current @ 30 kHz T_c = 75°C, D = 50%, V = 600V	**130A**	**130A**	**~3.1 x higher power density**
Current @ 50 kHz T_c = 75°C, D = 50%, V = 600V	**60A**	**115A**	**~2.0 x higher**
E_{on} + E_{off} @ 100A T_j = 150°C, V = 600V	**16.0 mJ**	**3.4 mJ**	**~5.0 x lower**



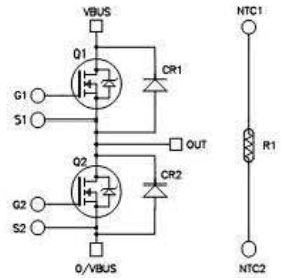
SP6C

MORE POWER @
HIGHER SWITCHING FREQUENCY
in
SMALLER VOLUME

SP1F

MICROCHIP

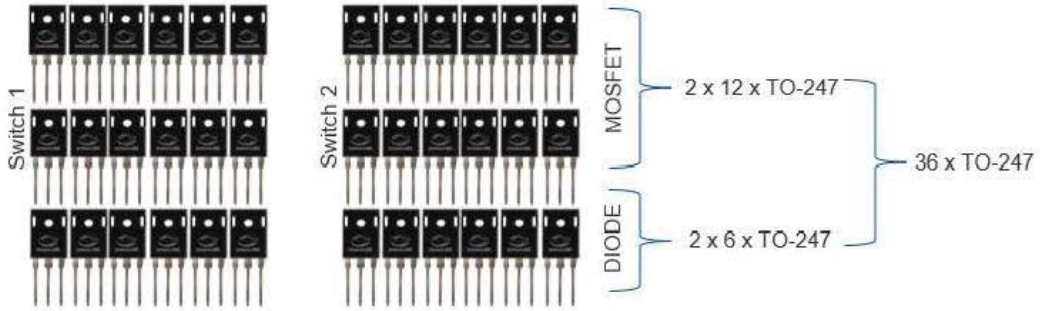
Comparison SP6LI vs. TO-247 Packages



MSCSM120AM02CT6LIAG

vs.

24 x MSC025SMA120B + 12 x MSC050SDA120B



	SP6LI power module	TO-247 discrete package	Power module benefits
MOSFET Electrical ratings	1200 V – 754 A @ Tc=80°C per switch	1200 V – 73 A @ Tc=100°C (non isolated) each	Higher power density ✓ ✓ ✓
Size	62 mm x 108 mm / 2.44" x 4.25"	36 x (15.87 mm x 21.13 mm / 0.625" x 0.832")	Easier mounting ✓ ✓
Mounting pcb area	6'696 mm2 / 10.37 sq. in.	Min. 13'950 mm2 / 21.62 sq. in. (mounting dependant)	Smaller system size ✓ ✓
Weight	320 g w/ Cu baseplate – 220 g w/ AlSiC	36 x 6.2 g = 223.2 g (no isolation)	More compact design ✓ ✓
Stray inductance	3 nH	20 nH	Higher efficiency ✓ ✓ ✓
Isolation	4 kV AC, 1mn - per design	None, to be added during assemlby	Higher reliability ✓ ✓ ✓
Thermal Management	Very good and repeatable	Complicated	Better thermal performance ✓ ✓ ✓
Temperature sensor	Yes, NTC	No, to be added externally	More accurate protection ✓ ✓ ✓
Assembly time	4 mounting holes + 14 electrical screws	36 mounting holes + 108 solder pins (additional labor)	Faster assembly time ✓ ✓ ✓
Cost (1 k pieces price basis)	$ 926.62 + minimum labor cost	$ 911.88 + high labor cost	Lower system cost ✓ ✓

MICROCHIP

Flexibility with mSiC™ Module Architectures

Standard, modified standard and custom modules

Power Semiconductor Die

SiC, IGBT, MOSFETs, Diode

- Soldered to the substrates
- Connected by ultrasonic Al wire bonds

Substrates

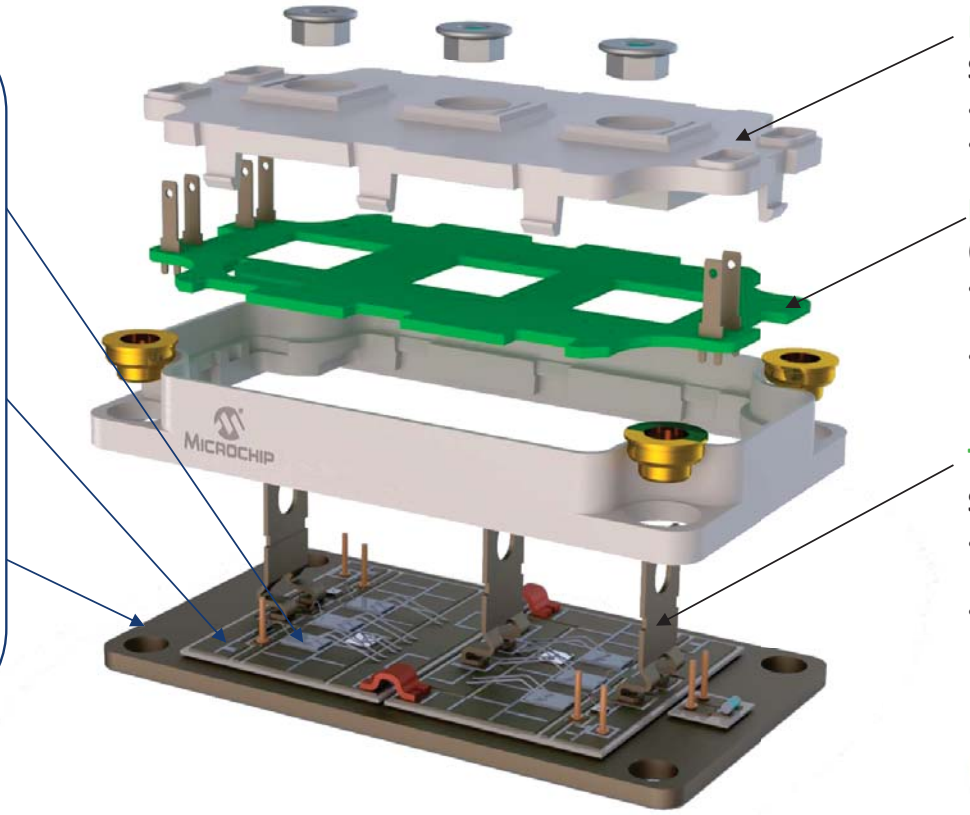
Al_2O_3, AlN, Si_3N_4

- Provide isolation
- Good heat transfer to the base plate

Base Plate

Improve Heat Transfer to the Heatsink

- Copper material for good thermal transfer
- AlSiC for improved reliability



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

Terminals

Screw on or Solder Pins

- Provide the user with power and signal connections
- Minimum parasitic resistance and inductance

High Design Flexibility

Empowering balance with price, performance and reliability

MICROCHIP

“Dyno Testing” State-of-the-Art SiC Power Modules

Quickly unlock the capabilities of SP6LI modules

- **Assess the performance of SP6LI mSiC™ MOSFET modules**
  - Switching loss measurement (E_{on}, E_{off} and E_{rr})
  - High-side and low-side DSAT (over current)*
  - High voltage evaluation (1200V modules)
  - Over various thermal conditions

- **Continuous operation and double-pulse testing (DPT) evaluation**

- **Reduce risk - evaluate and optimize in a controlled environment**

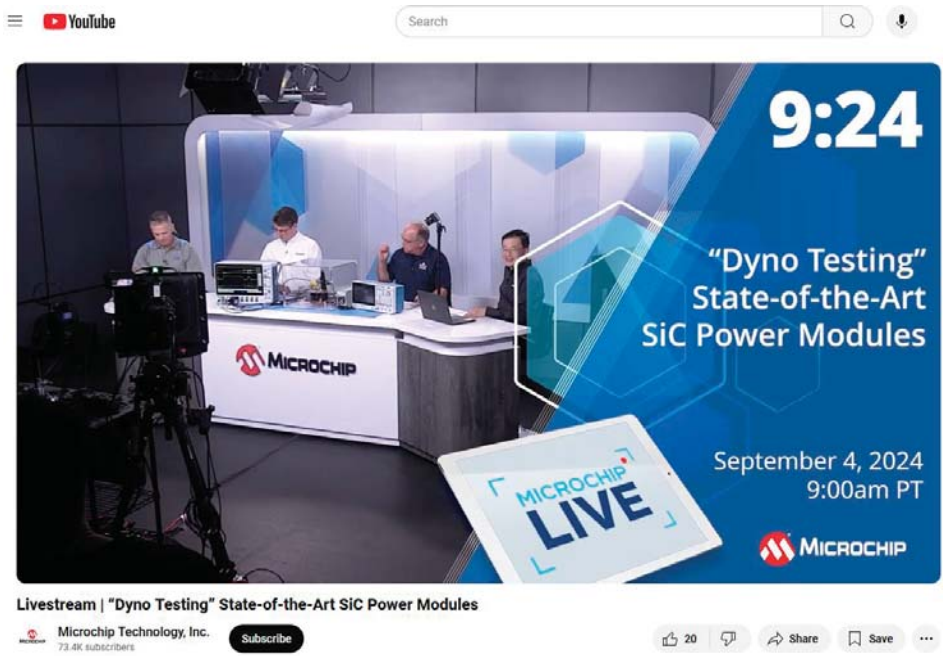
Main applications:

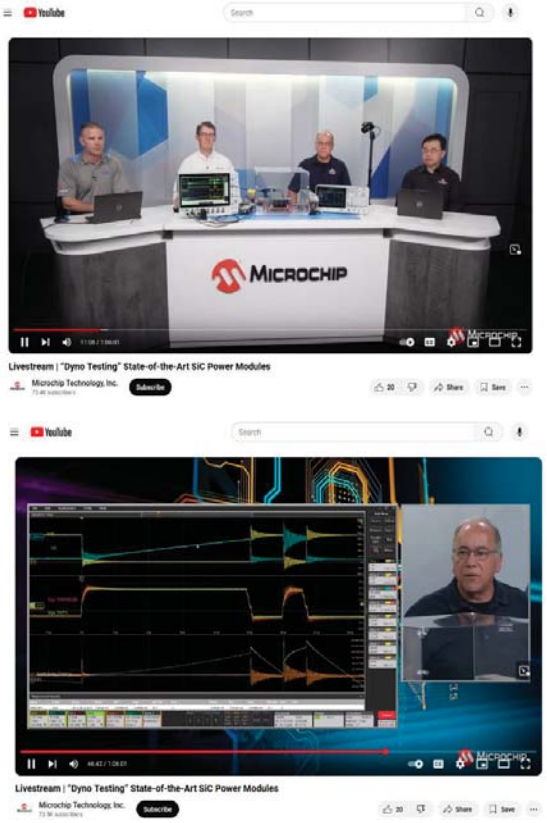
- Electrified vehicles
- EV chargers
- Industrial equipment
- Solar power
- Energy storage
- Factory automation
- AI power

MICROCHIP

“Dyno Testing” State-of-the-Art SiC Power Modules

Scenes SiC Livestream on SP6LI Double Pulse Testing





YouTube https://www.youtube.com/live/anRhNqwlq1I

MICROCHIP

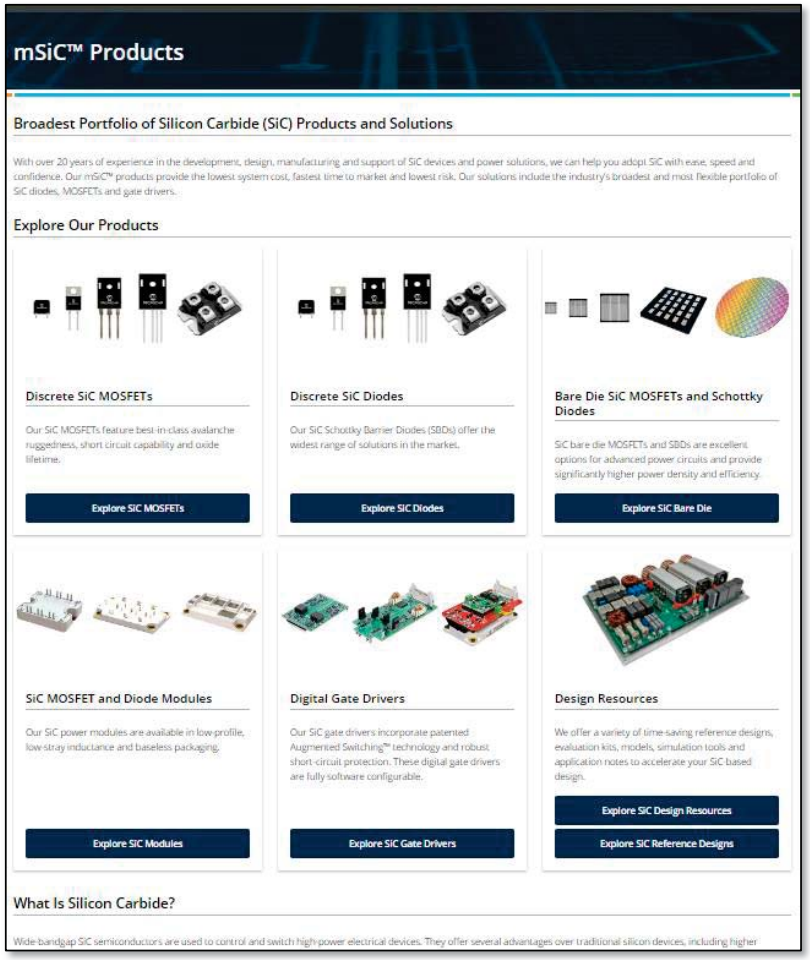
Summary

- Broad Market Acceptance that SiC saves cost at the system level
- To get even more out of SiC, new packaging is required to make systems more efficient, compact, and longer-lasting
- Today we have looked at the impact of parasitic inductance
- Comparing the SP6LI to the common 62 mm package, the end user can save over $1,000 per module per year
- SP6LI solution is superior to discretes and suitable up to megawatt-scale power levels

MICROCHIP

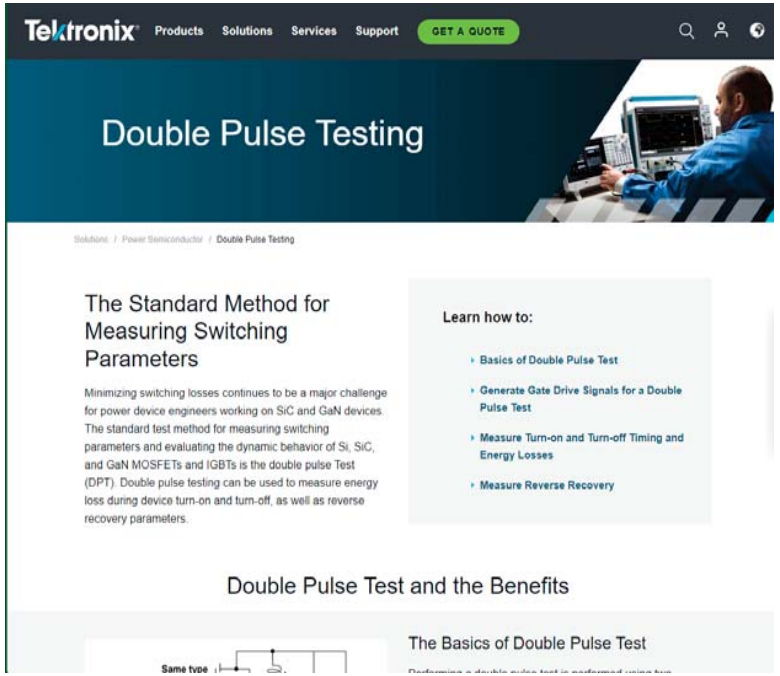
mSiC™ Solutions Portal

www.microchip.com/SiC and www.Tektronix.com



PRIVACY.FLOWCODE.COM

SCAN ME



- Video: Double Pulse Testing of Wide Bandgap Devices | Tektronix
- Testing Equipment: Wide Bandgap Double Pulse Reference Solution | Tektronix

Thank You

Adopt Silicon Carbide with Ease, Speed and Confidence

www.microchip.com/SiC

MICROCHIP