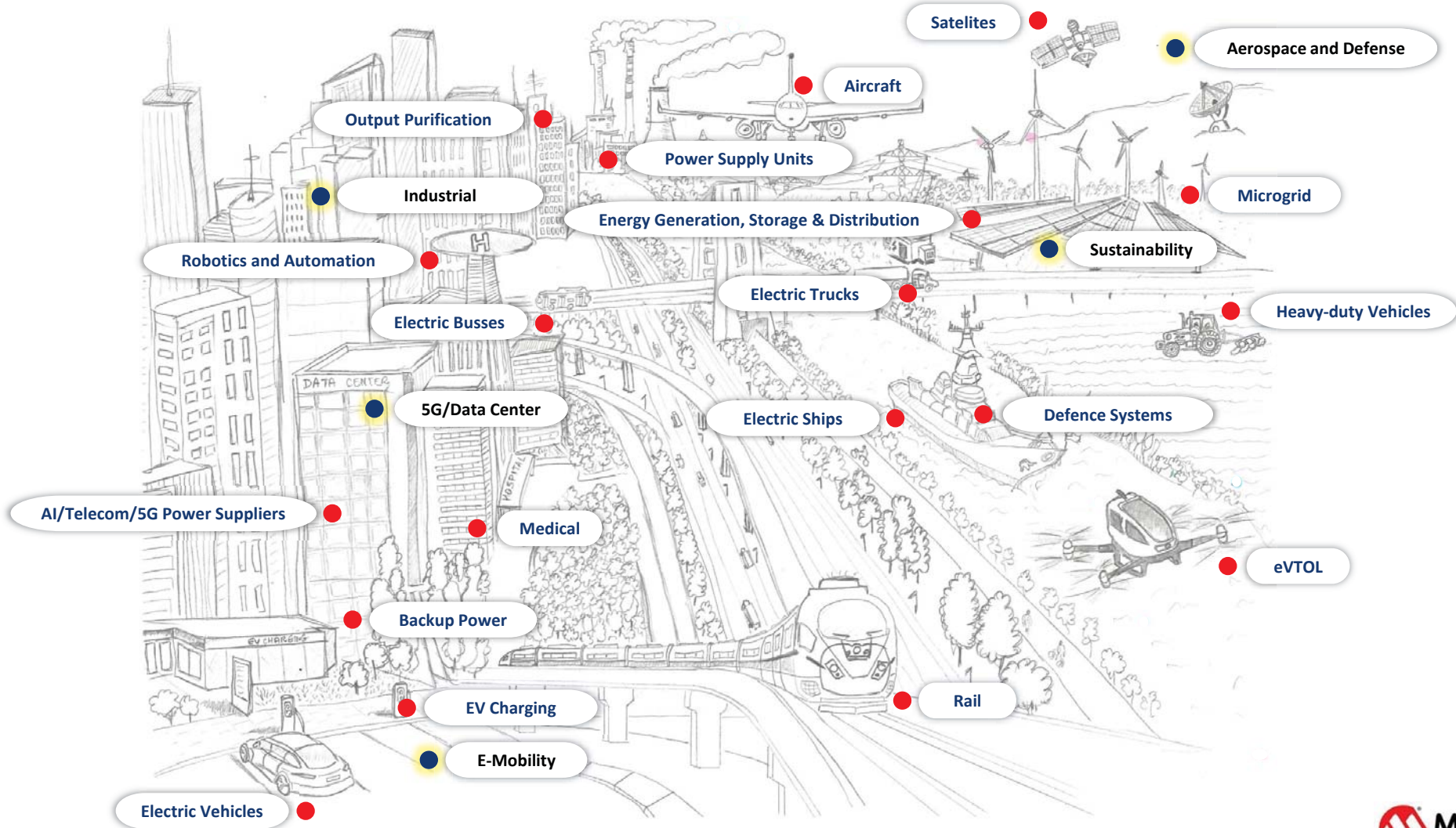


# The Next Wave of SiC Packaging and mSiC™ Products

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Marketing Solutions | SiC BU

# The Electrification of Everything



# Riding the Second Wave of Silicon Carbide (SiC)

## First Wave

SiC die in existing packages

## Second Wave

SiC die in higher performing packages

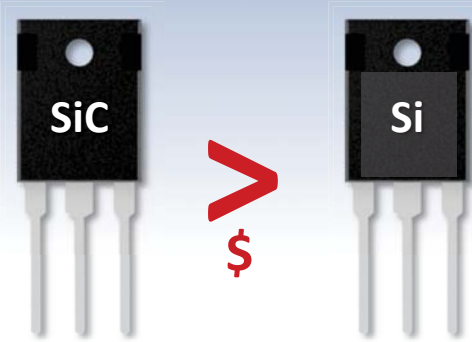
## Third Wave

Higher Voltage SiC Solutions

# 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...



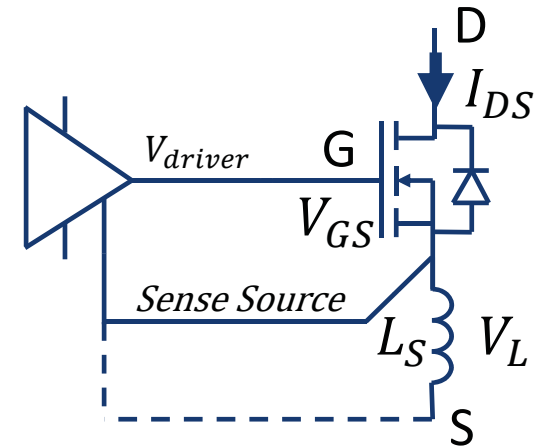
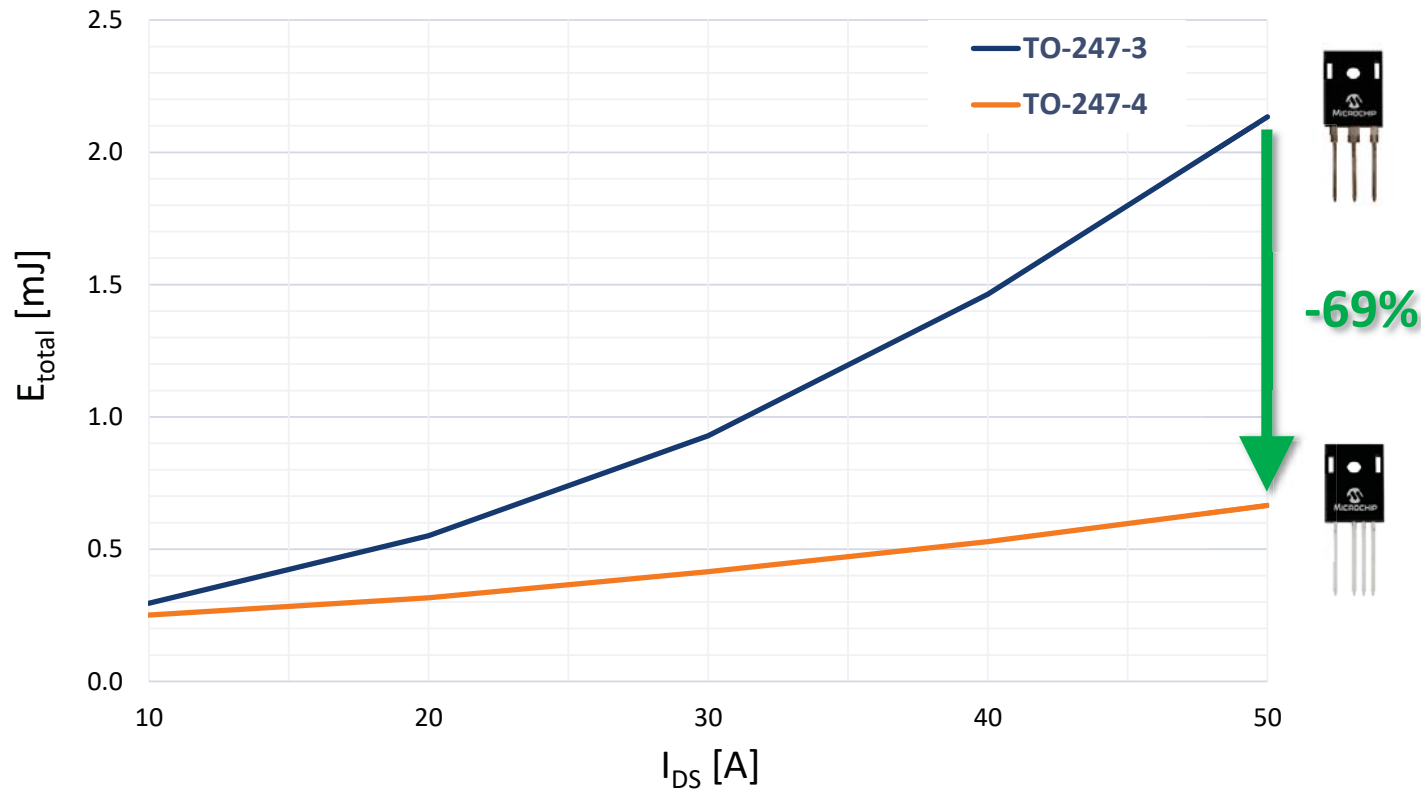
In addition to cutting their cost, SiC can make systems:

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

# TO-247 Performance Improvement

## Source sense pin for faster turn on and lower switching losses

1200V, 80 mΩ mSiC™ MOSFET  
 $R_G = 5\Omega$ ,  $V_{DS} = 750V$ ,  $V_{GS} = -5V/20V$ ,  $T_A = 25^\circ C$

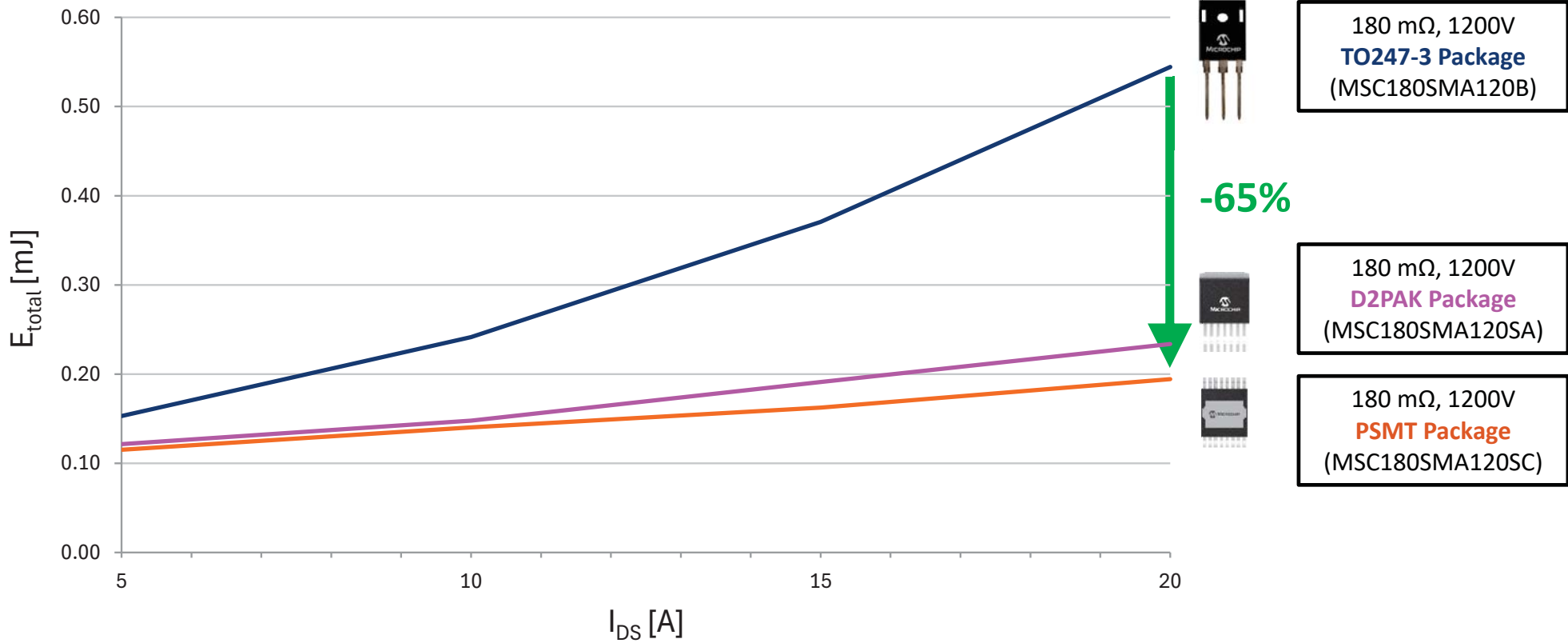


$$V_{GS} = V_{driver} - L_S \frac{dI_{DS}}{dt}$$
$$V_{GS} = V_{driver} - V_L$$

# Pushing Beyond The TO-247 with SMT Packages

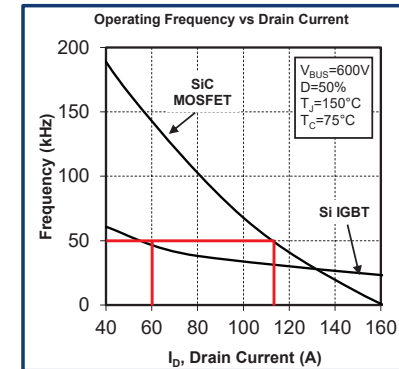
## Source sense pins and top-side cooled

1200V, 180 m $\Omega$  mSiC™ MOSFET  
 $R_G = 5\Omega$ ,  $V_{DS} = 800V$ ,  $V_{GS} = -5V/20V$ ,  $T_A = 25^\circ C$



# SiC Power Modules For Even Higher Density

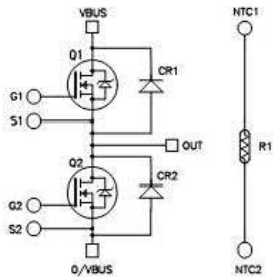
Parameter	Microchip APTGLQ300A120G	Microchip MSCSM120AM16CT1AG	Comparison SiC vs Si
<b>Semiconductor type</b>	Trench4 Fast IGBT	mSiC™ MOSFET	
<b>Ratings @ <math>T_c = 25^\circ\text{C}</math></b>	<b>500A / 1200V</b>	<b>173A / 1200V</b>	
<b>Package type</b>	<b>SP6C (108 x 62 mm)</b>	<b>SP1F (52 x 41 mm)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



**MORE POWER @  
HIGHER SWITCHING FREQUENCY  
in  
SMALLER VOLUME**



# Comparison SP6LI vs. TO-247 Packages

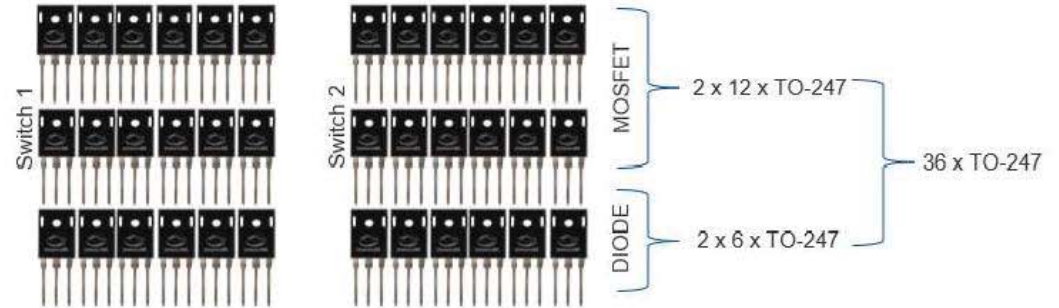


MSCSM120AM02CT6LIAG



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 mm <sup>2</sup> / 10.37 sq. in.	Min. 13'950 mm <sup>2</sup> / 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 assembly	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 ✓ ✓



# 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

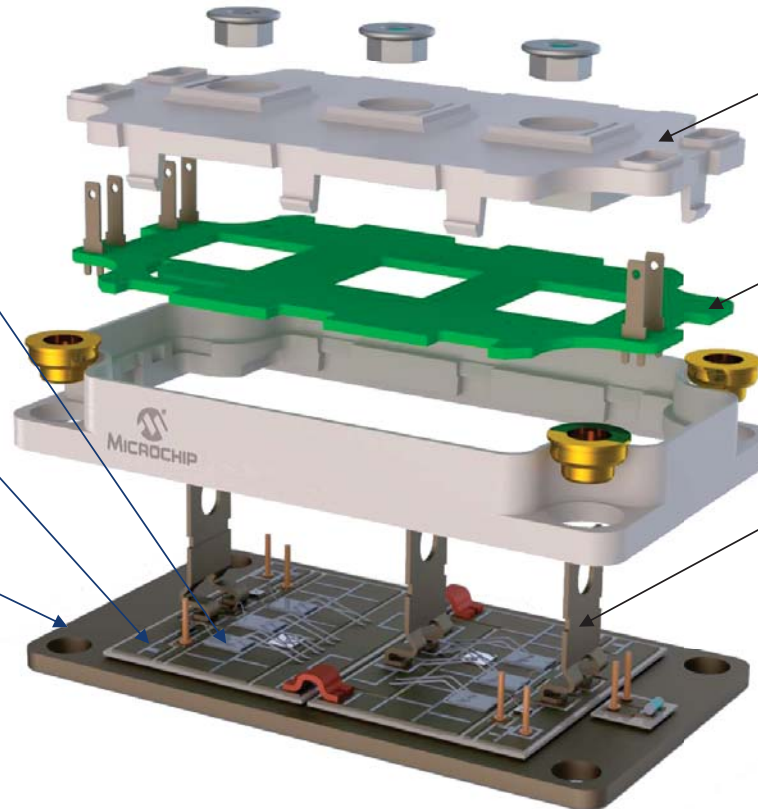
#### Al<sub>2</sub>O<sub>3</sub>, AlN, Si<sub>3</sub>N<sub>4</sub>

- 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

# “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**

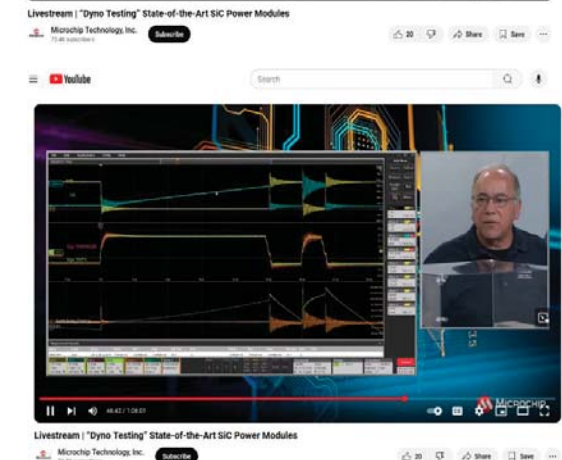
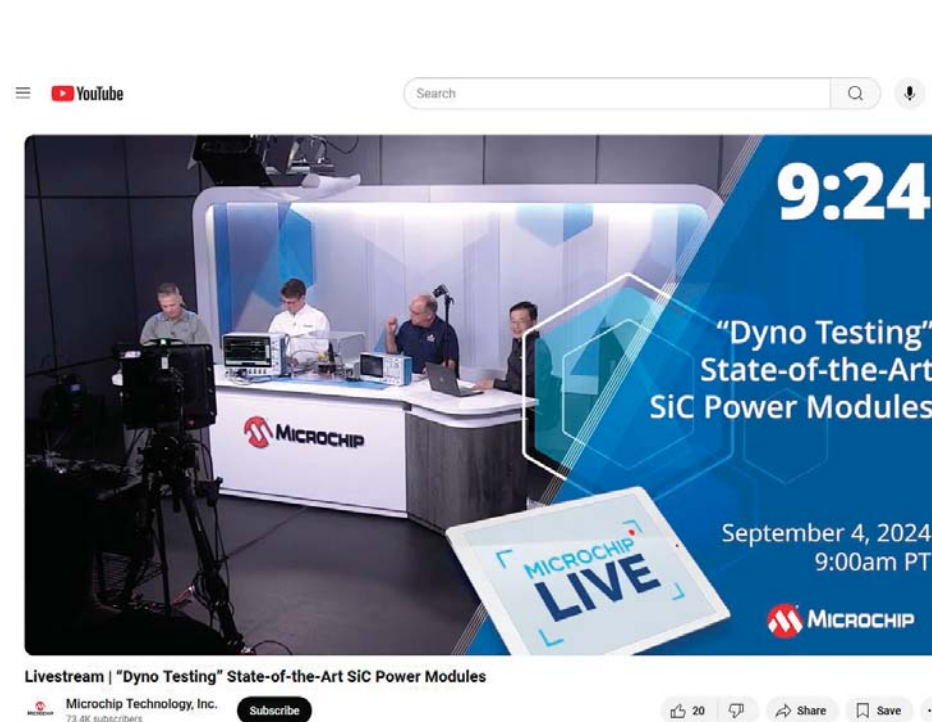


### Main applications:

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

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

## Scenes SiC Livestream on SP6LI Double Pulse Testing



YouTube <https://www.youtube.com/live/anRhNqwlq1>

# 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**

# mSiC™ Solutions Portal

[www.microchip.com/SiC](http://www.microchip.com/SiC)

and

[www.Tektronix.com](http://www.Tektronix.com)

**mSiC™ Products**

**Broadest Portfolio of Silicon Carbide (SiC) Products and Solutions**

With over 20 years of experience in the development, design, manufacturing and support of SiC devices and power solutions, we can help you adopt SiC with ease, speed and confidence. Our mSiC™ products provide the lowest system cost, fastest time to market and lowest risk. Our solutions include the industry's broadest and most flexible portfolio of SiC diodes, MOSFETs and gate drivers.

**Explore Our Products**

- Discrete SiC MOSFETs**  
Our SiC MOSFETs feature best-in-class avalanche ruggedness, short circuit capability and oxide lifetime.  
[Explore SiC MOSFETs](#)
- Discrete SiC Diodes**  
Our SiC Schottky Barrier Diodes (SBDs) offer the widest range of solutions in the market.  
[Explore SiC Diodes](#)
- Bare Die SiC MOSFETs and Schottky Diodes**  
SiC bare-die MOSFETs and SBDs are excellent options for advanced power circuits and provide significantly higher power density and efficiency.  
[Explore SiC Bare Die](#)
- SiC MOSFET and Diode Modules**  
Our SiC power modules are available in low profile, low-stray inductance and baseless packaging.  
[Explore SiC Modules](#)
- Digital Gate Drivers**  
Our SiC gate drivers incorporate patented Augmented Switching™ technology and robust short-circuit protection. These digital gate drivers are fully software configurable.  
[Explore SiC Gate Drivers](#)
- Design Resources**  
We offer a variety of time-saving reference designs, evaluation kits, models, simulation tools and application notes to accelerate your SiC-based design.  
[Explore SiC Design Resources](#)  
[Explore SiC Reference Designs](#)

**What Is Silicon Carbide?**

Wide bandgap SiC semiconductors are used to control and switch high-power electrical devices. They offer several advantages over traditional silicon devices, including higher



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## Double Pulse Testing

Solutions / Power Semiconductor / Double Pulse Testing


### The Standard Method for Measuring Switching Parameters

Minimizing switching losses continues to be a major challenge for power device engineers working on SiC and GaN devices. The standard test method for measuring switching parameters and evaluating the dynamic behavior of Si, SiC, and GaN MOSFETs and IGBTs is the double pulse test (DPT). Double pulse testing can be used to measure energy loss during device turn-on and turn-off, as well as reverse recovery parameters.

**Learn how to:**

- Basics of Double Pulse Test
- Generate Gate Drive Signals for a Double Pulse Test
- Measure Turn-on and Turn-off Timing and Energy Losses
- Measure Reverse Recovery

### Double Pulse Test and the Benefits

Same type 

[The Basics of Double Pulse Test](#)

- [Video: Double Pulse Testing of Wide Bandgap Devices | Tektronix](#)
- [Testing Equipment: Wide Bandgap Double Pulse Reference Solution | Tektronix](#)



# Thank You

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