

**MSCMC120AM04CT6LIAG**

**Datasheet**

**Very Low Stray Inductance Phase Leg SiC MOSFET Power  
Module**

Final

May 2018



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# 1 **Revision History**

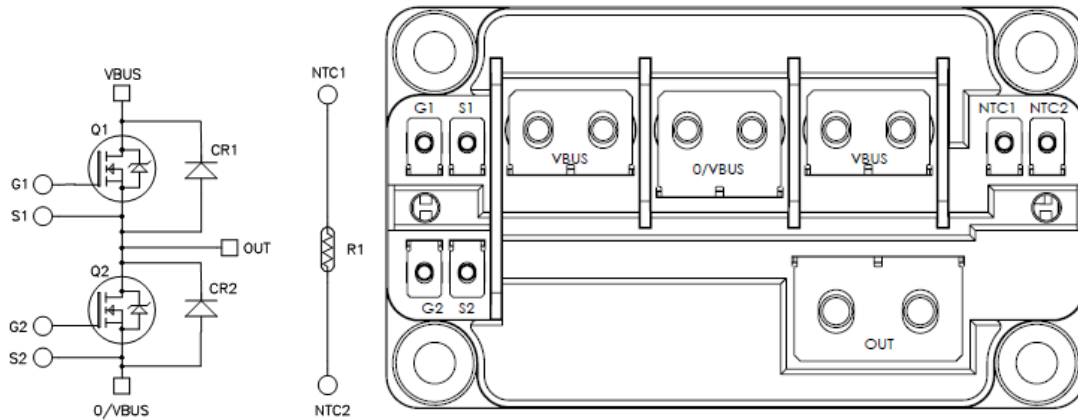
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The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

## 1.1 **Revision A**

Revision A was published in May 2018. It is the first publication of this document.

## 2 Product Overview



### 2.1 Features

The following are key features of the MSCMC120AM04CT6LIAG device:

- Very low stray inductance
- Internal thermistor for temperature monitoring
- M4 and M5 power connectors
- M2.5 signals connectors
- AlN substrate for improved thermal performance

#### SiC Power MOSFET

- Low  $R_{DS(on)}$
- High temperature performance

#### SiC Schottky Diode

- Zero reverse recovery
- Zero forward recovery
- Temperature independent switching behavior
- Positive temperature coefficient on VF

### 2.2 Benefits

The following are benefits of the MSCMC120AM04CT6LIAG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Low profile
- RoHS compliant

### 2.3 Applications

The MSCMC120AM04CT6LIAG device is designed for the following applications:

- Motor control

\*All ratings taken at  $T_J = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Caution: The devices are sensitive to electrostatic discharge. Proper handling precautions should be followed.

### 3 Electrical Specifications

This section details the electrical specifications for the MSCMC120AM04CT6LIAG device.

#### 3.1 Absolute Maximum Ratings

The following table shows the SiC MOSFET absolute maximum ratings (per SiC MOSFET) for the MSCMC120AM04CT6LIAG device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameter		Ratings	Unit
$V_{DS}$	Drain- source voltage		1200	V
$I_D$	Continuous drain current	$T_c = 25\text{ }^{\circ}\text{C}$	388	A
		$T_c = 80\text{ }^{\circ}\text{C}$	307	
$I_{DM}$	Pulsed drain current		780	
$V_{GS}$	Gate- source voltage		–10 to 23	V
$V_{GSOP}$	Gate- source voltage; recommended operation values		–5 to 18	
$R_{DS(on)}$	Drain- source ON resistance		5.7	m $\Omega$
$P_D$	Power dissipation	$T_c = 25\text{ }^{\circ}\text{C}$	1754	W

## 3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC120AM04CT6LIAG device.

**Table 2 • Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$I_{OSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 1200\text{ V}$		100	600	$\mu\text{A}$
$R_{DS(on)}$	Drain- source on resistance	$V_{GS} = 20\text{ V}$ ; $I_D = 300\text{ A}$ $T_J = 25\text{ }^\circ\text{C}$		4.2	5.7	$\text{m}\Omega$
		$V_{GS} = 18\text{ V}$ ; $I_D = 300\text{ A}$ $T_J = 175\text{ }^\circ\text{C}$		8.6		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 90\text{ mA}$	2	2.6	4	V
$I_{GSS}$	Gate- source leakage current	$V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$			7.2	$\mu\text{A}$

**Table 3 • Dynamic Characteristics**

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$		16.7		nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$		1.32		
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$		0.09		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ to }20\text{ V}$		966		nC
$Q_{gs}$	Gate – source charge	$V_{Bus} = 800\text{ V}$		276		
$Q_{gd}$	Gate – drain charge	$I_D = 300\text{ A}$		300		
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5\text{ to }20\text{ V}$		21		ns
$T_r$	Rise time	$V_{Bus} = 600\text{ V}$		19		
$T_{d(off)}$	Turn-off delay time	$I_D = 300\text{ A}$		50		
$T_f$	Fall time	$R_L = 2\text{ }\Omega$ ; $R_G = 0.5\text{ }\Omega$		30		
$E_{on}$	Turn on energy	Inductive Switching $T_J = 150\text{ }^\circ\text{C}$		4.45		mJ
$E_{off}$	Turn off energy	$V_{GS} = -5\text{ to }20\text{ V}$		2.9		
		$V_{Bus} = 600\text{ V}$				
		$I_D = 300\text{ A}$ $R_G = 0.5\text{ }\Omega$				
$R_{Gint}$	Internal gate resistance			0.85		$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance				0.086	$^\circ\text{C/W}$

**Table 4 • Body Diode Ratings and Characteristics**

Symbol	Characteristic	Test conditions		Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = -5\text{ V}$	$T_J = 25\text{ °C}$		4		V
		$I_{SD} = 150\text{ A}$	$T_J = 175\text{ °C}$		3.5		
$t_{rr}$	Reverse recovery time	$I_{SD} = 300\text{ A} ; V_{GS} = -5\text{ V}$			45		ns
$Q_{rr}$	Reverse recovery charge	$V_R = 800\text{ V} ; di_F/dt = 6000\text{ A}/\mu\text{s}$			2.45		$\mu\text{C}$
$I_{rr}$	Reverse recovery current				81		A

The following table shows the SiC diode characteristics of the MSCMC120AM04CT6LIAG device.

**Table 5 • SiC Diode Characteristics (per SiC diode)**

Symbol	Characteristics	Test conditions		Min	Typ	Max	Unit
$V_{RRM}$	Peak repetitive reverse voltage					1200	V
$I_{RM}$	Reverse leakage current	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$		0.4	2	mA
			$T_J = 175\text{ °C}$		1.2	4	
$I_F$	DC forward current	$T_C = 100\text{ °C}$			200		A
$V_F$	Diode forward voltage	$I_F = 200\text{ A}$	$T_J = 25\text{ °C}$		1.6	1.8	V
			$T_J = 175\text{ °C}$		2.25	2.7	
$Q_C$	Total capacitive charge	$V_R = 800\text{ V}$			984		nC
$C$	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$			920		pF
		$f = 1\text{ MHz}, V_R = 800\text{ V}$			692		
$R_{thJC}$	Junction-to-case thermal resistance					0.135	°C/W

The following tables show the thermal and package characteristics of the MSCMC120AM04CT6LIAG device.

**Table 6 • Package Characteristics**

Symbol	Characteristic			Min	Max	Unit
V <sub>ISOL</sub>	RMS isolation voltage, any terminal to case t =1 min, 50 to 60 Hz			4000		V
T <sub>J</sub>	Operating junction temperature range			−40	175	°C
T <sub>JOP</sub>	Recommended junction temperature under switching conditions			−40	T <sub>Jmax</sub> −25	
T <sub>STG</sub>	Storage temperature range			−40	125	
T <sub>C</sub>	Operating case temperature			−40	125	
Torque	Mounting torque	For terminals	M2.5	0.4	0.6	N.m
			M4	2	3	
			M5	2	3.5	
			To heatsink	M6	3	5
L <sub>DC</sub>	Module stray inductance between VBUS and 0/VBUS				3	nH
Wt	Package weight				320	g

**Table 7 • Temperature Sensor NTC**

Symbol	Characteristic	Min	Typ	Max	Unit
R <sub>25</sub>	Resistance at 25 °C		50		kW
ΔR <sub>25</sub> /R <sub>25</sub>			5		%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15 K		3952		K
ΔB/B	T <sub>C</sub> = 100 °C		4		%

**Note:** See application note APT0406 on [www.microsemi.com](http://www.microsemi.com)

**Figure 1 • NTC Formula**

$$R_T = \frac{R_{25}}{\exp \left[ B_{25/85} \left( \frac{1}{T_{25}} - \frac{1}{T} \right) \right]}$$

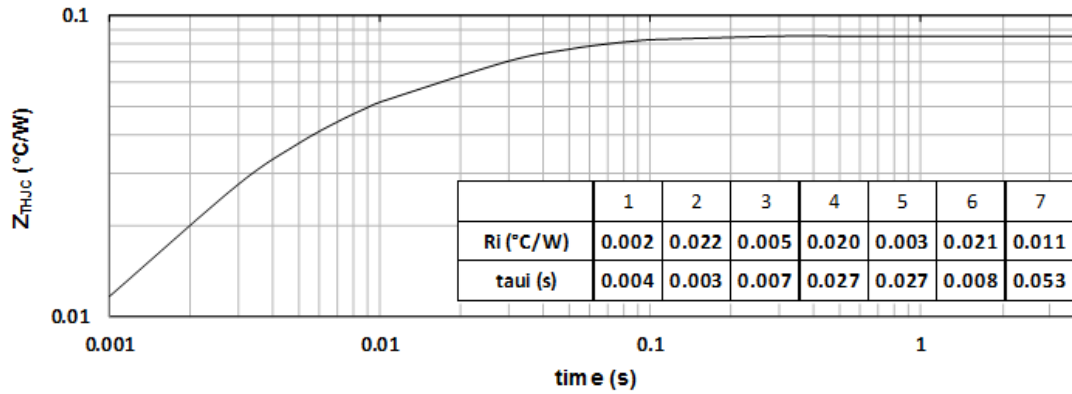


### 3.3 Typical Performance Curves

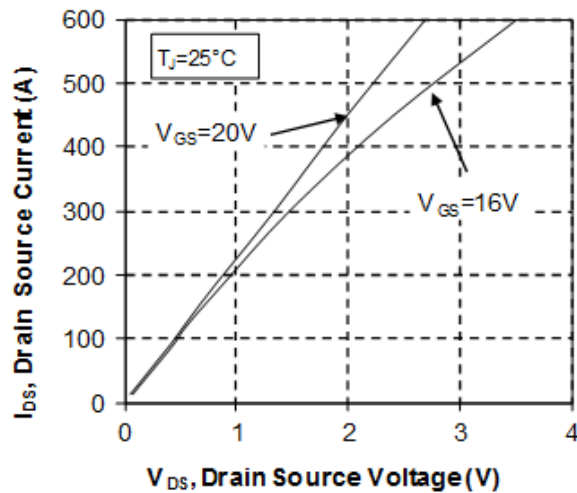
This section shows the typical performance curves for the MSCMC120AM04CT6LIAG device.

The following section details the typical performance curves for SiC MOSFET.

**Figure 2 • Maximum Thermal Impedance**



**Figure 3 • Output Characteristics**



**Figure 4 • Output Characteristics II**

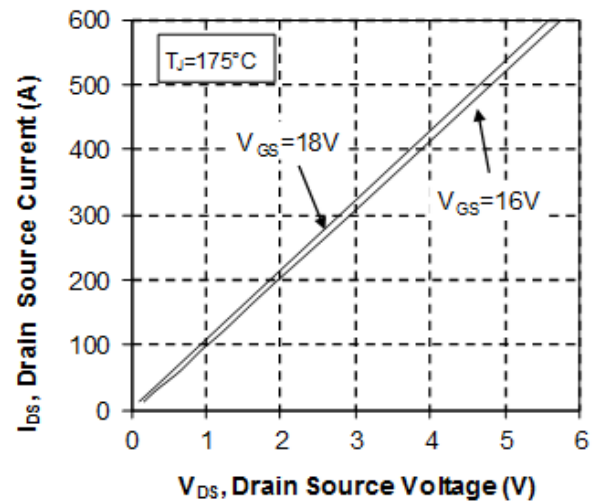


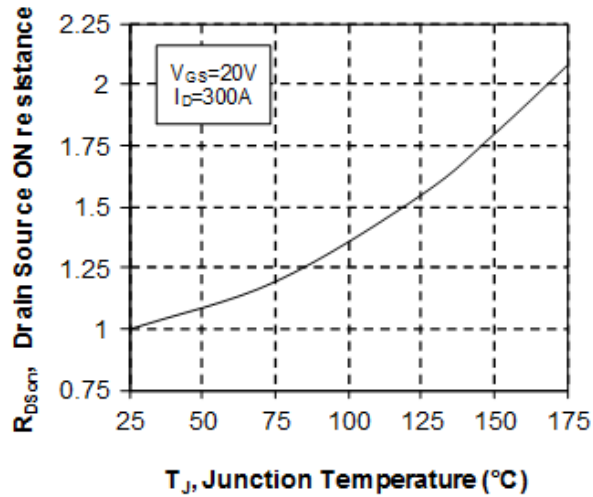
Figure 5 • Normalized  $R_{DS(on)}$  vs. Temperature

Figure 6 • Transfer Characteristics

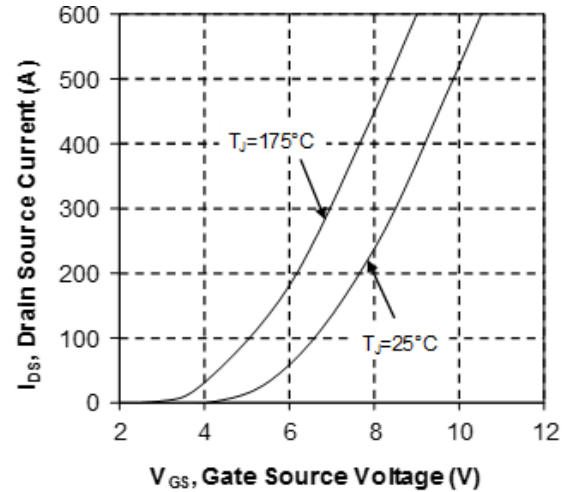
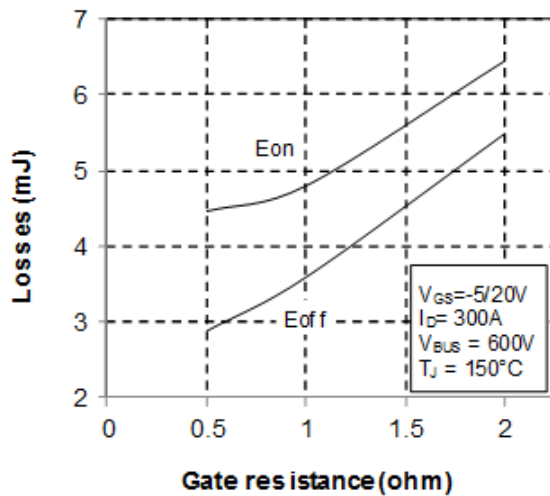
Figure 7 • Switching Energy vs.  $R_g$ 

Figure 8 • Switching Energy vs. Current

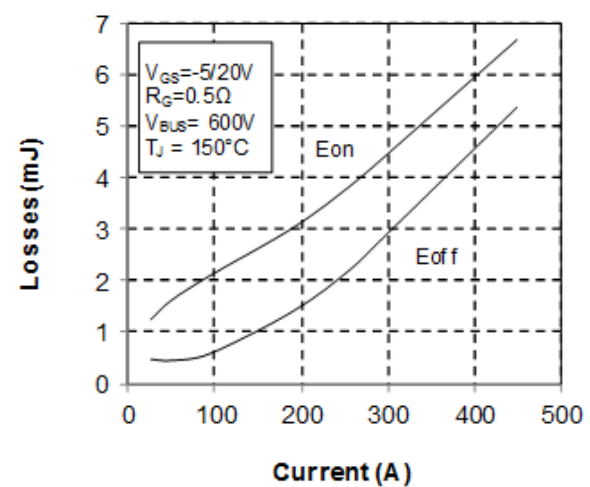


Figure 9 • Capacitance vs. Drain Source Voltage

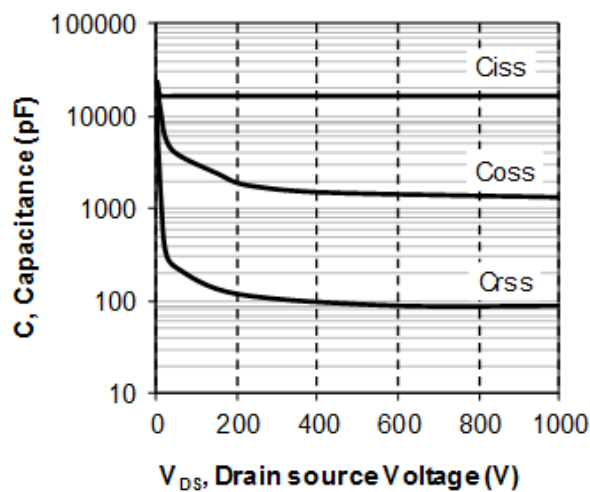


Figure 10 • Gate Charge vs. Gate Source Voltage

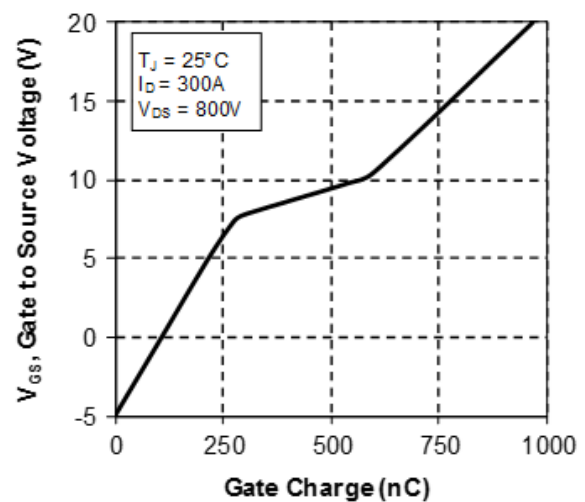


Figure 11 • Body Diode Characteristics

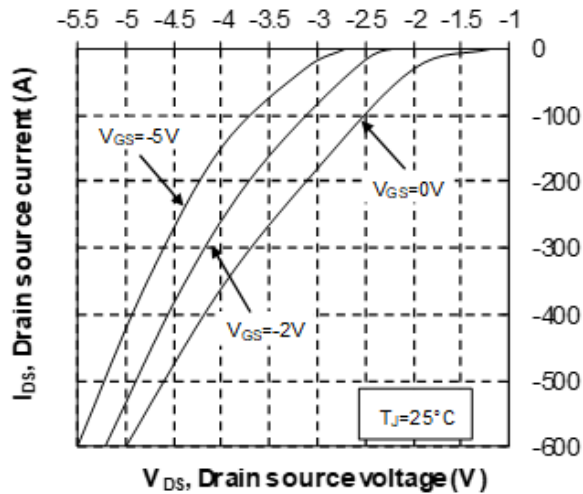


Figure 12 • 3rd Quadrant Characteristics

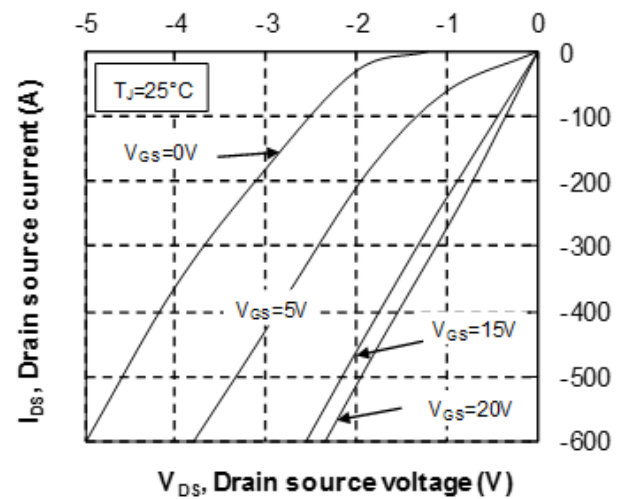


Figure 13 • Body Diode Characteristics II

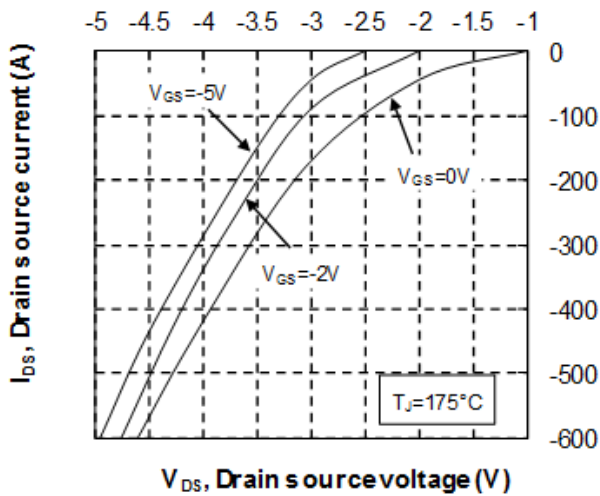


Figure 14 • 3rd Quadrant Characteristics

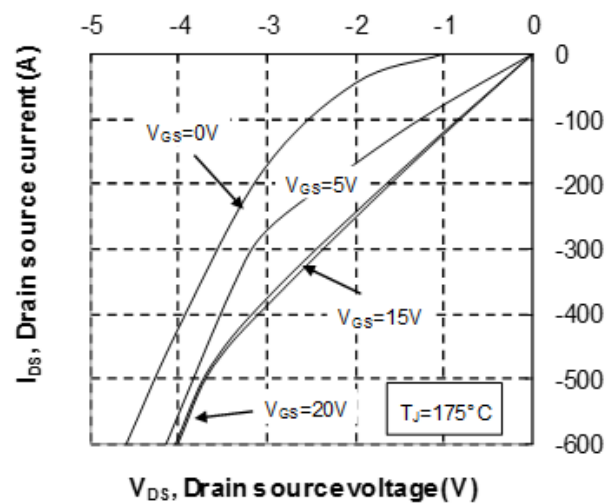
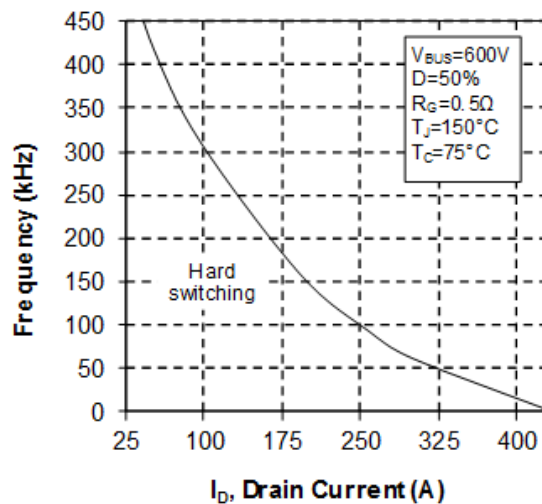
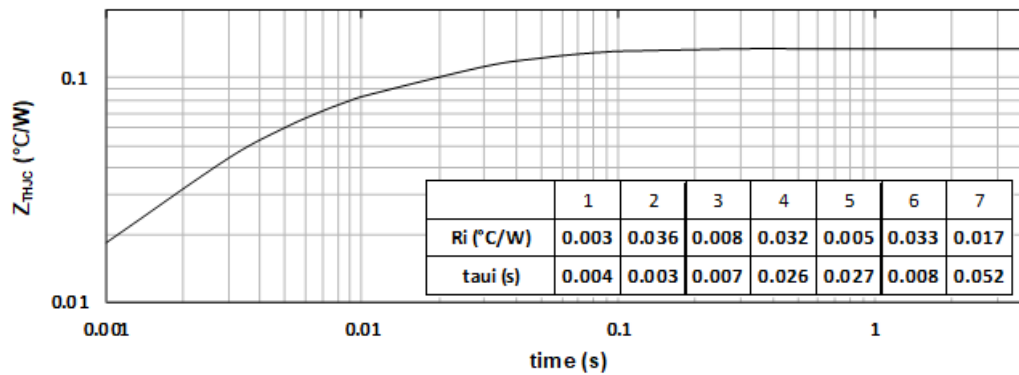


Figure 15 • Operating Frequency vs. Drain Current

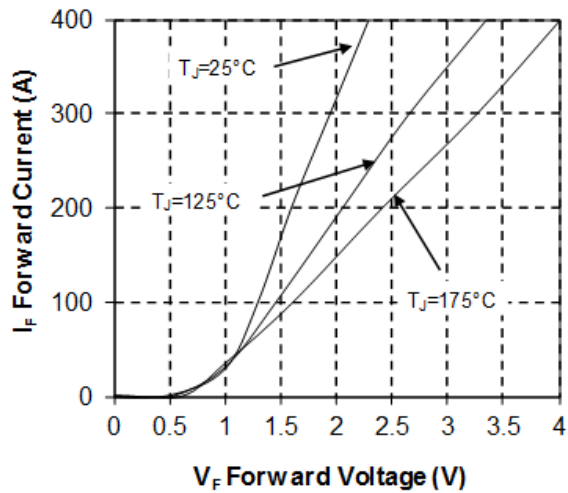


The following section details the typical performance curves for SiC Diode.

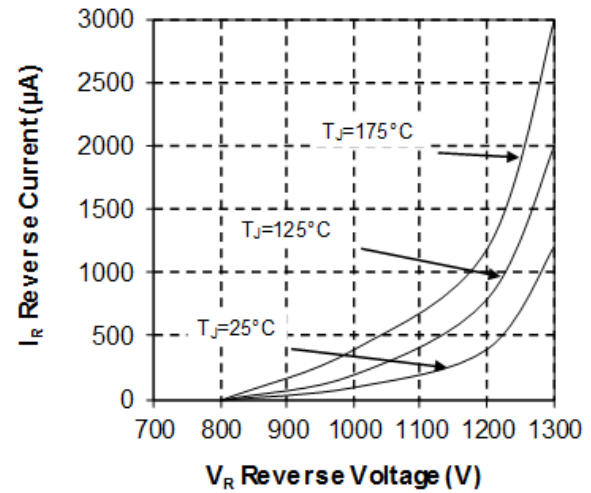
**Figure 16 • SiC Diode Maximum Thermal Impedance**



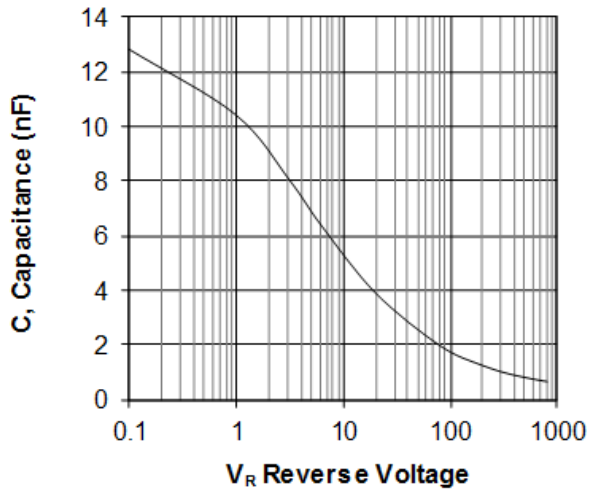
**Figure 17 • Forward Characteristics**



**Figure 18 • Reverse Characteristics**



**Figure 19 • Capacitance vs. Reverse Voltage**



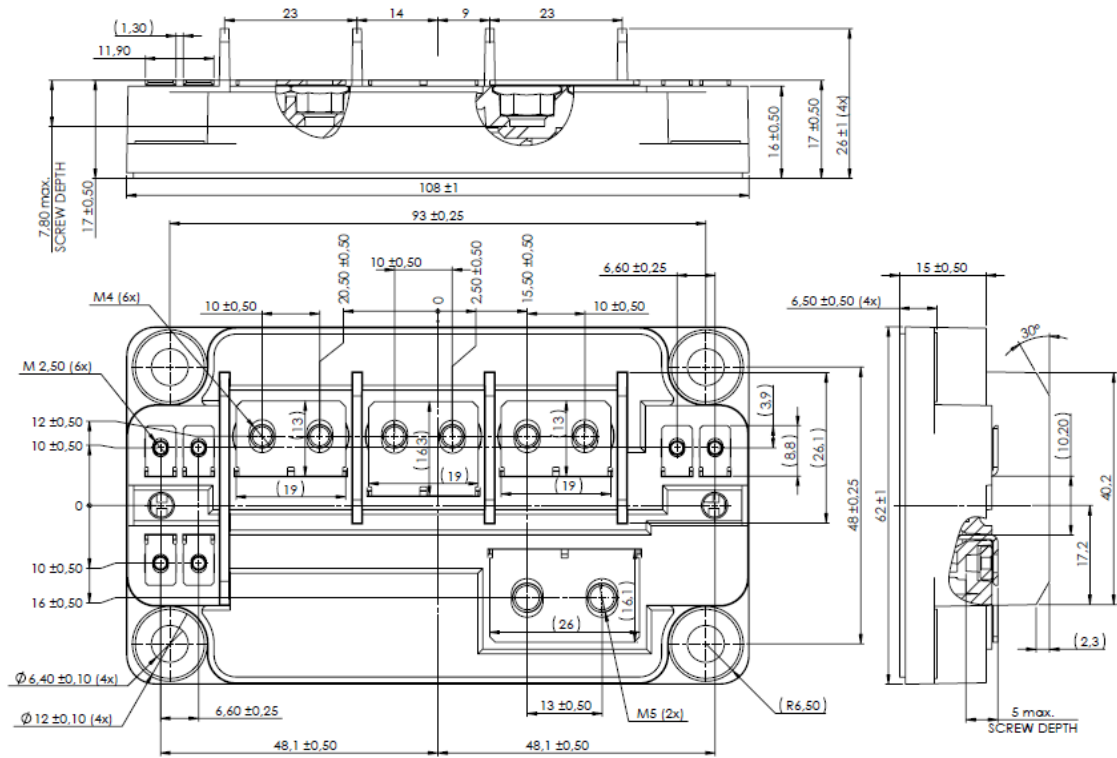
## 4 Package Specification

This section outlines the package specification for the MSCMC120AM04CT6LIAG device.

### 4.1 Package Outline Drawing

This section details the package drawing of the MSCMC120AM04CT6LIAG device. Dimensions are in millimeters.

**Figure 20 • Package Outline Drawing**



**Note:** See application note AN1911 containing the mounting instructions for SP6 low inductance power module on [www.microsemi.com](http://www.microsemi.com)

**Microsemi Corporate Headquarters**

One Enterprise, Aliso Viejo,  
CA 92656 USA  
Within the USA: +1 (800) 713-4113  
Outside the USA: +1 (949) 380-6100  
Fax: +1 (949) 215-4996  
Email: [sales.support@microsemi.com](mailto:sales.support@microsemi.com)  
[www.microsemi.com](http://www.microsemi.com)

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