

**MSCMC120AM03CT6LIAG**

**Datasheet**

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

Final

May 2018



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# 1 Revision History

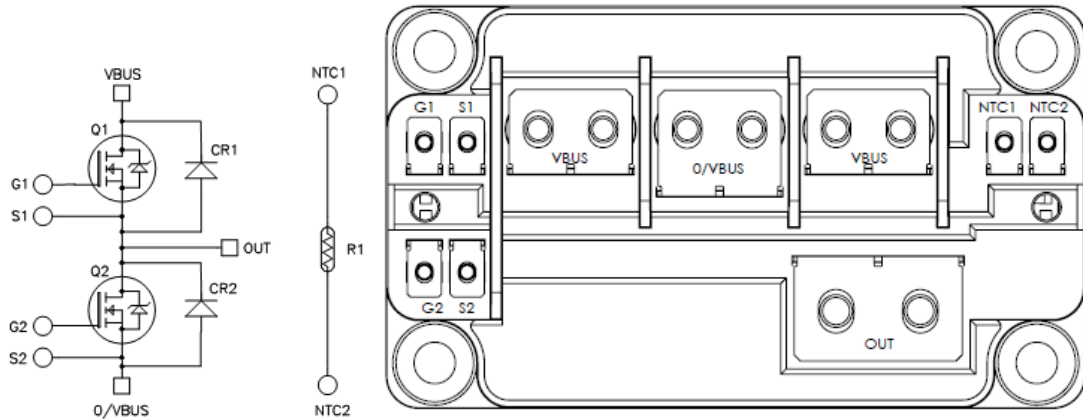
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The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

## 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 MSCMC120AM03CT6LIAG 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 MSCMC120AM03CT6LIAG 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 MSCMC120AM03CT6LIAG 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 (ESD). Proper handling procedures should be followed.

### 3 Electrical Specifications

This section details the electrical specifications for the MSCMC120AM03CT6LIAG device.

#### 3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSCMC120AM03CT6LIAG device (per SiC MOSFET).

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameter		Ratings	Unit
$V_{DS}$	Drain- source voltage		1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	631	A
		$T_C = 80\text{ }^\circ\text{C}$	475	
$I_{DM}$	Pulsed drain current		1200	
$V_{GS}$	Gate- source voltage		-5 to 23	V
$V_{GSOP}$	Gate- source voltage; recommended operation values		-5 to 18	
$R_{DS(on)}$	Drain- source ON resistance		3.4	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	2778	W

## 3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC120AM03CT6LIAG device.

**Table 2 • Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I <sub>DSS</sub>	Zero gate voltage drain current	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 1200 V		200	1000	μA
R <sub>DS(on)</sub>	Drain- source on resistance	V <sub>GS</sub> = 20 V; I <sub>D</sub> = 500 A		2.5	3.4	mΩ
		V <sub>GS</sub> = 18 V; I <sub>D</sub> = 500 A	T <sub>J</sub> = 25 °C	5.2		
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 150 mA	2	2.6	4	V
I <sub>GSS</sub>	Gate- source leakage current	V <sub>GS</sub> = 20 V, V <sub>DS</sub> = 0 V			6	μA

**Table 3 • Dynamic Characteristics**

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
C <sub>iss</sub>	Input capacitance	V <sub>GS</sub> = 0 V		27.9		nF
C <sub>oss</sub>	Output capacitance	V <sub>DS</sub> = 1000 V		2.2		
C <sub>rss</sub>	Reverse transfer capacitance	f = 1 MHz		0.15		
Q <sub>g</sub>	Total gate charge	V <sub>GS</sub> = -5 to 20 V		1610		nC
Q <sub>gs</sub>	Gate – source charge	V <sub>Bus</sub> = 800 V		460		
Q <sub>gd</sub>	Gate – drain charge	I <sub>D</sub> = 500 A		500		
T <sub>d(on)</sub>	Turn-on delay time	V <sub>GS</sub> = -5 to 20 V		21		ns
T <sub>r</sub>	Rise time	V <sub>Bus</sub> = 600 V		19		
T <sub>d(off)</sub>	Turn-off delay time	I <sub>D</sub> = 500 A		50		
T <sub>f</sub>	Fall time			30		
		R <sub>L</sub> = 1.2 Ω ; R <sub>G</sub> = 0.3 Ω				
E <sub>on</sub>	Turn on energy	Inductive Switching		7.4		mJ
		V <sub>GS</sub> = -5 to 20 V	T <sub>J</sub> = 150 °C	4.8		
E <sub>off</sub>	Turn off energy	V <sub>Bus</sub> = 600 V	T <sub>J</sub> = 150 °C			
		I <sub>D</sub> = 500 A				
		R <sub>G</sub> = 0.3 Ω				
R <sub>Gint</sub>	Internal gate resistance			0.71		Ω
R <sub>thjc</sub>	Junction-to-case thermal resistance				0.054	°C/W

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

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
V <sub>SD</sub>	Diode forward voltage	V <sub>GS</sub> = -5 V	T <sub>J</sub> = 25 °C	4		V
		I <sub>SD</sub> = 250 A	T <sub>J</sub> = 175 °C	3.5		
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 500 A ; V <sub>GS</sub> = -5 V		45		ns
Q <sub>rr</sub>	Reverse recovery charge			4		μC
I <sub>rr</sub>	Reverse recovery current	V <sub>R</sub> = 800 V ; di <sub>r</sub> /dt = 10000 A/μs		135		A

The following table shows the SiC diode characteristics (per SiC diode) of the MSCMC120AM03CT6LIAG device.

**Table 5 • SiC Diode Characteristics**

Symbol	Characteristics	Test conditions	Min	Typ	Max	Unit
$V_{RRM}$	Peak repetitive reverse voltage				1200	V
$I_{RM}$	Reverse leakage current	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$	0.5	2.5	mA
			$T_J = 175\text{ °C}$	1.5	5	
$I_F$	DC forward current			250		A
$V_F$	Diode forward voltage	$I_F = 250\text{ A}$	$T_J = 25\text{ °C}$	1.6	1.8	V
			$T_J = 175\text{ °C}$	2.25	2.7	
$Q_C$	Total capacitive charge	$V_R = 800\text{ V}$		1230		nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$		1150		pF
			$f = 1\text{ MHz}, V_R = 800\text{ V}$	865		
$R_{thJC}$	Junction-to-case thermal resistance				0.106	°C/W

The following tables show the thermal and package characteristics of the MSCMC120AM03CT6LIAG device.

**Table 6 • Package Characteristics**

Symbol	Characteristic	Min	Max	Unit		
$V_{ISOL}$	RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50 to 60 Hz	4000		V		
$T_J$	Operating junction temperature range	-40	175	°C		
$T_{JOP}$	Recommended junction temperature under switching conditions	-40	$T_{max} - 25$			
$T_{STG}$	Storage temperature range	-40	125			
$T_C$	Operating case temperature	-40	125			
Torque	Mounting torque	For terminals	M2.5	0.4	0.6	Nm
			M4	2	3	
			M5	2	3.5	
		To heatsink	M6	3	5	
$L_{DC}$	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
$R_{25}$	Resistance at 25 °C		50		kΩ
$\Delta R_{25}/R_{25}$			5		%
$B_{25/85}$	$T_{25} = 298.15\text{ K}$		3952		K
$\Delta B/B$	$T_C = 100\text{ °C}$		4		%

**Figure 1 • NTC Formula**

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

T: Thermistor temperature R<sub>T</sub>: Thermistor value at T

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

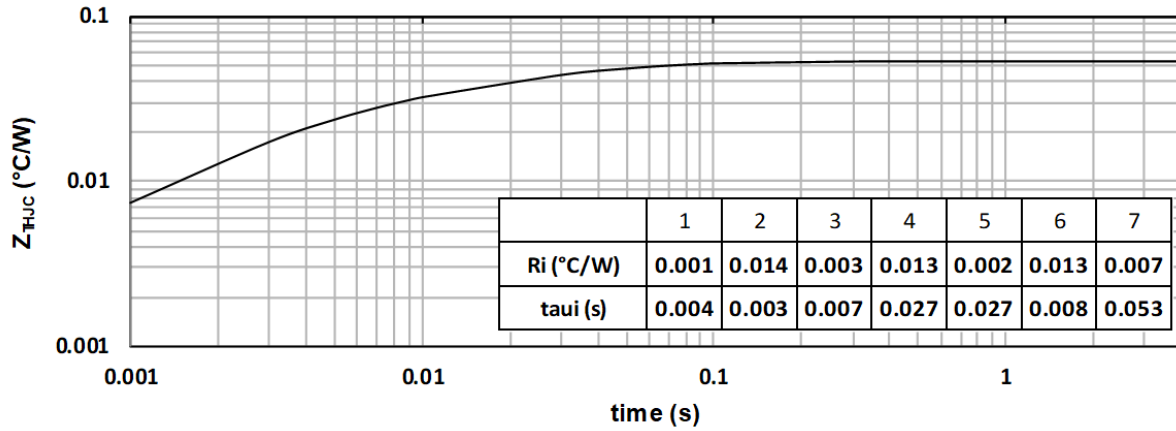


### 3.3 Typical Performance Curves

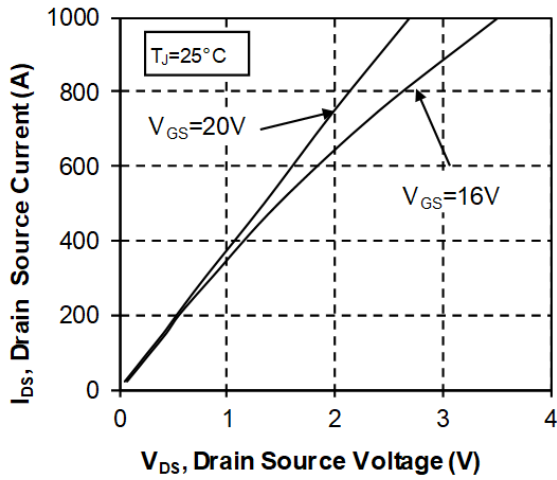
This section shows the typical performance curves for the MSCMC120AM03CT6LIAG device.

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**

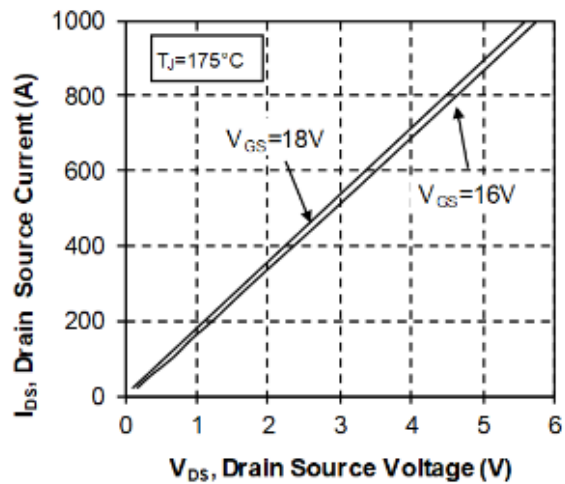


Figure 5 • Normalized RDS(on) vs. Temperature

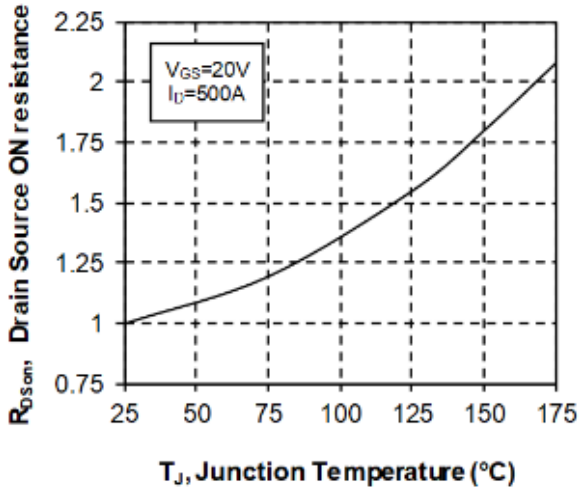


Figure 6 • Transfer Characteristics

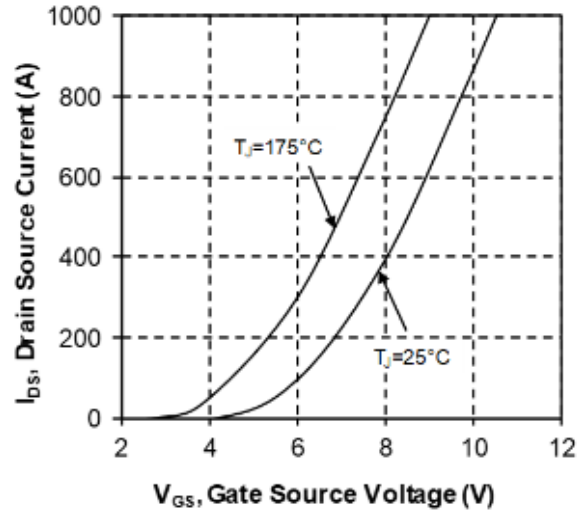


Figure 7 • Switching Energy vs. Rg

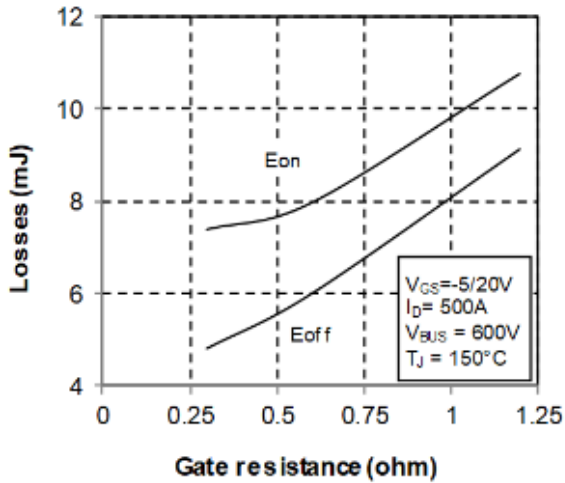


Figure 8 • Switching Energy vs. Current

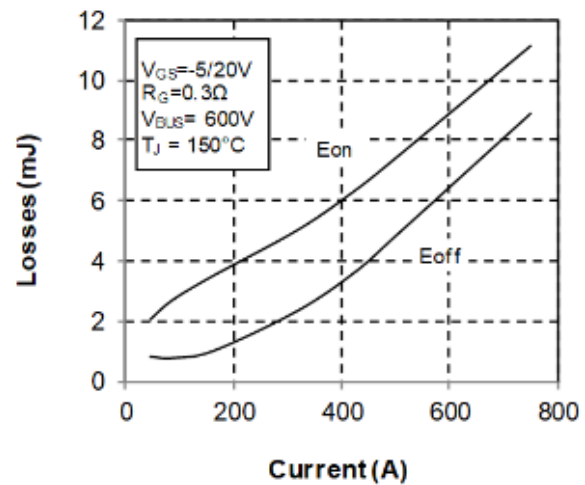


Figure 9 • Capacitance vs. Drain Source Voltage

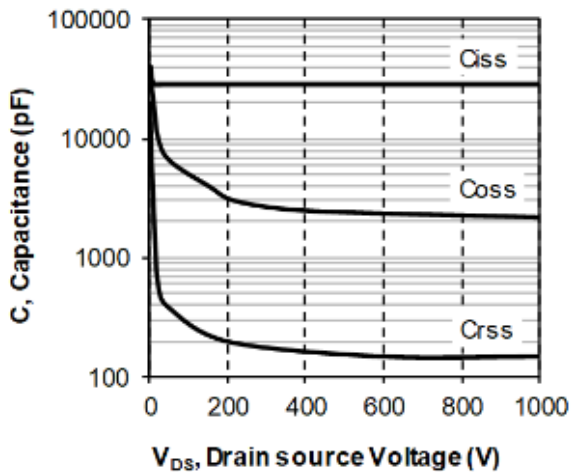


Figure 10 • Gate Charge vs. Gate Source Voltage

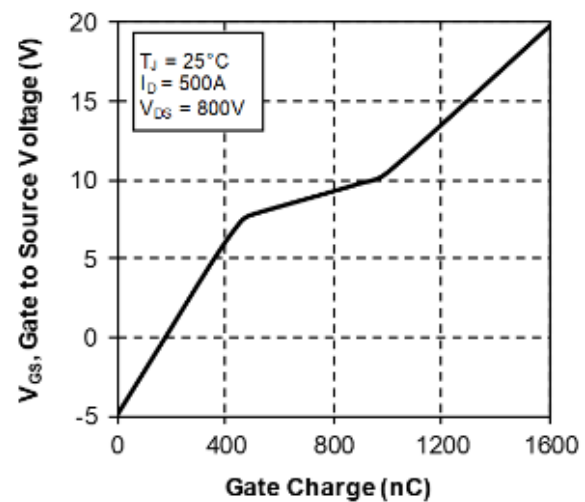


Figure 11 • Body Diode Characteristics

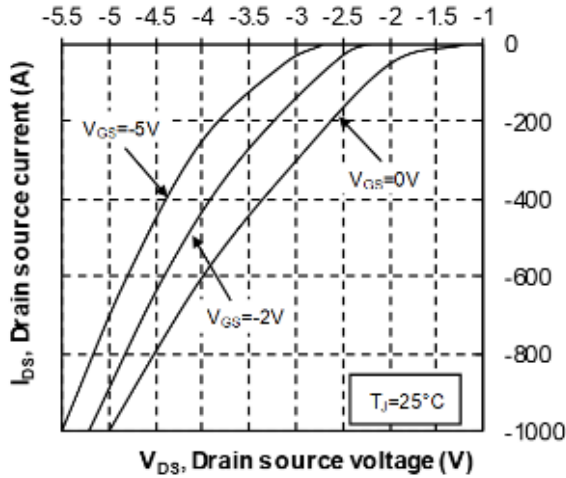


Figure 12 • 3rd Quadrant Characteristics

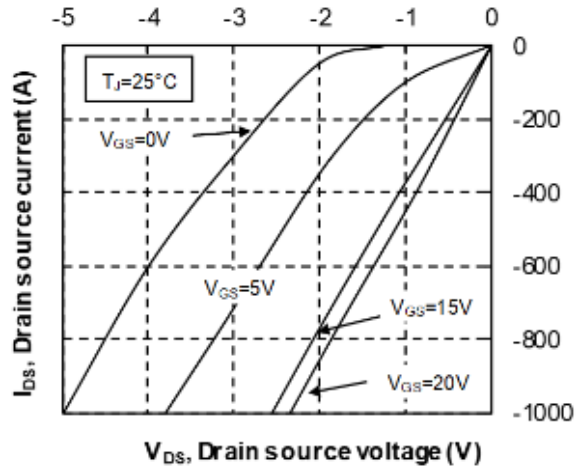


Figure 13 • Body Diode Characteristics II

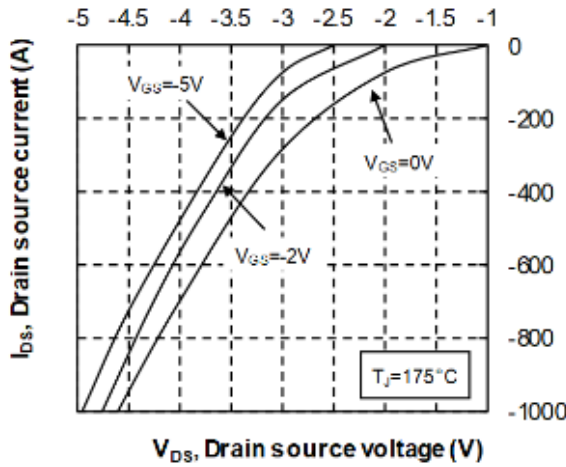


Figure 14 • 3rd Quadrant Characteristics

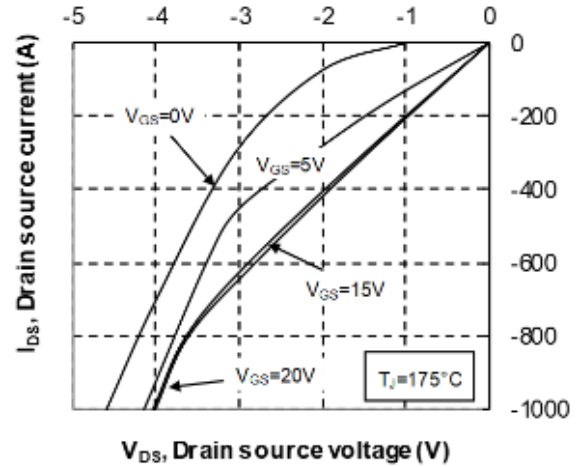
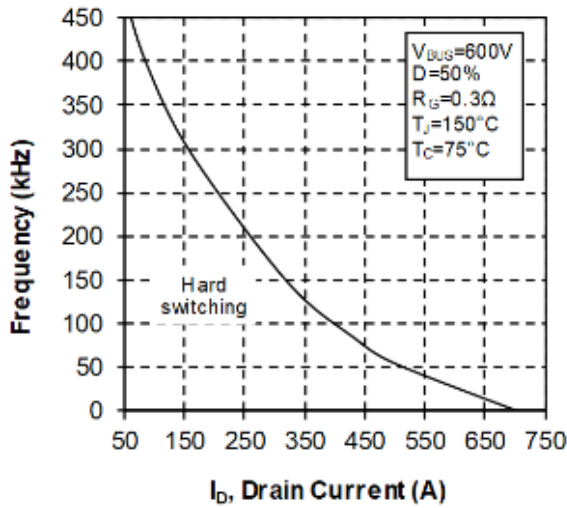
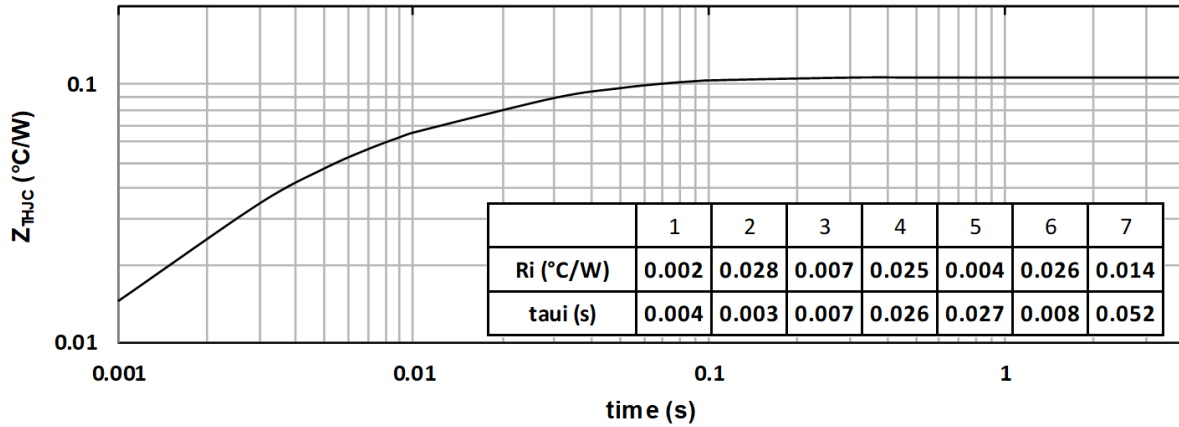


Figure 15 • Operating Frequency vs. Drain Current

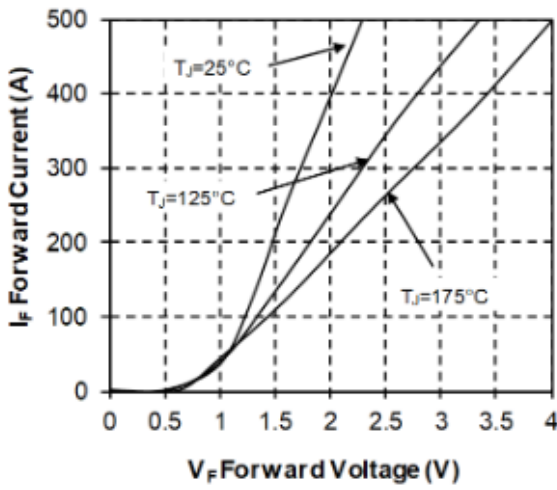


The following section details the typical performance curves for SiC Diode.

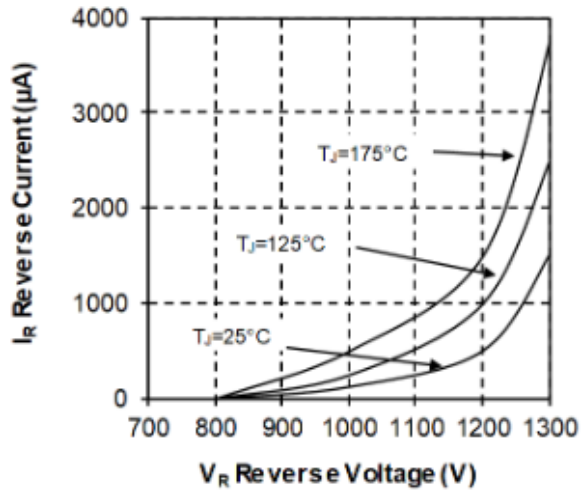
**Figure 16 • SiC Diode Maximum Thermal Impedance**



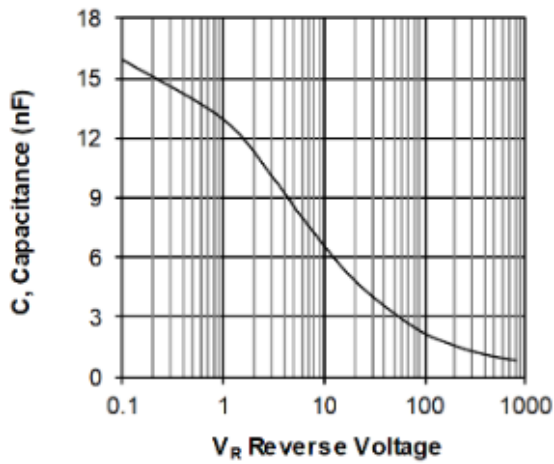
**Figure 17 • Forward Characteristics**



**Figure 18 • Reverse Characteristics**



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



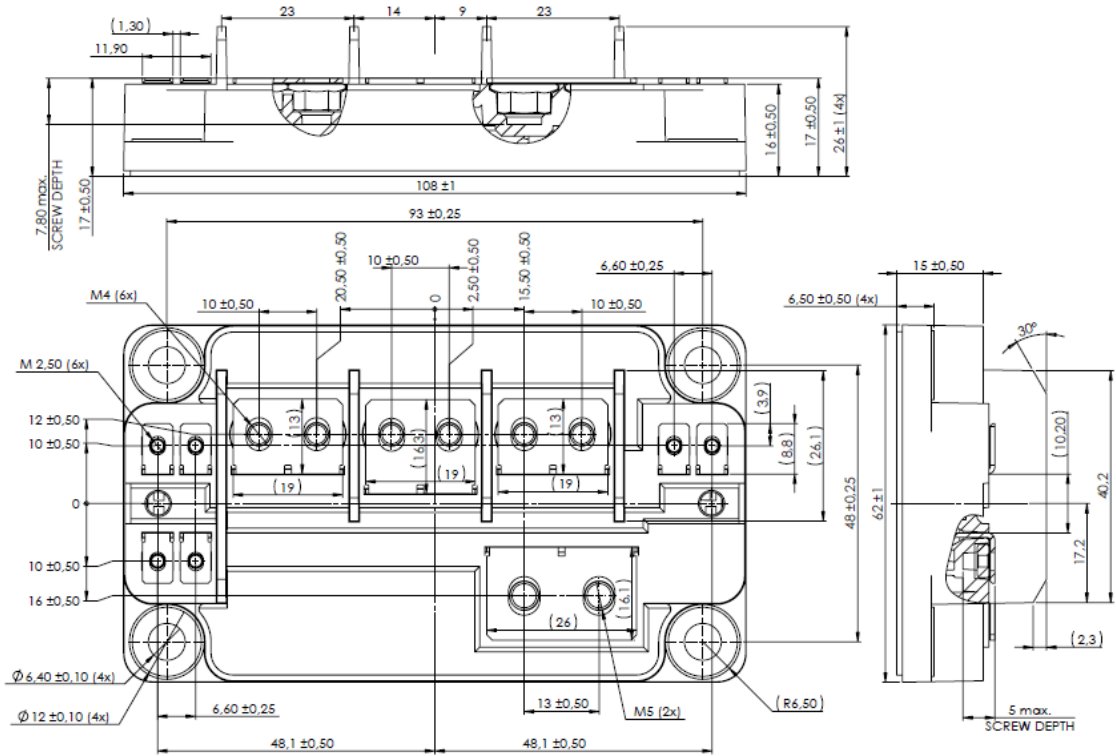
## 4 Package Specification

This section shows the package specification for the MSCMC120AM03CT6LIAG device.

### 4.1 Package Outline Drawing

This section details the package drawing of the MSCMC120AM03CT6LIAG device. Dimensions are in millimeters.

Figure 20 • Package Outline Drawing



Note: See the AN1911 application note at [www.microsemi.com](http://www.microsemi.com).

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