

MSCMC120AM03CT6LIAG

Datasheet

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

Final

May 2018



Contents

1	Revision History	1
1.1	Revision A	1
2	Product Overview	2
2.1	Features	2
2.2	Benefits	2
2.3	Applications	2
3	Electrical Specifications	3
3.1	Absolute Maximum Ratings	3
3.2	Electrical Performance	4
3.3	Typical Performance Curves	7
4	Package Specification	11
4.1	Package Outline Drawing	11

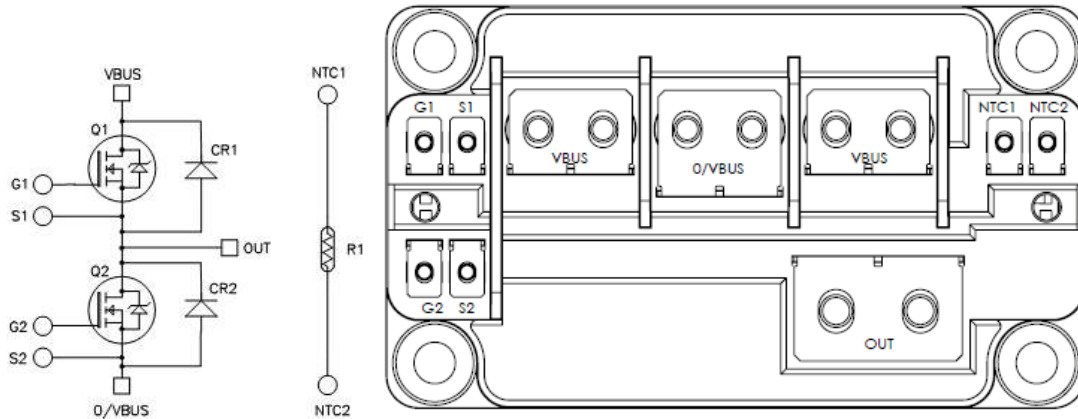
1 Revision History

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 Ω
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_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 1200\text{ V}$		200	1000	μA
$R_{DS(on)}$	Drain- source on resistance	$V_{GS} = 20\text{ V}$; $I_D = 500\text{ A}$ $T_j = 25\text{ }^\circ\text{C}$		2.5	3.4	$\text{m}\Omega$
		$V_{GS} = 18\text{ V}$; $I_D = 500\text{ A}$ $T_j = 175\text{ }^\circ\text{C}$		5.2		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$, $I_D = 150\text{ mA}$	2	2.6	4	V
I_{GSS}	Gate- source leakage current	$V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$			6	μA

Table 3 • Dynamic Characteristics

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$		27.9		nF
C_{oss}	Output capacitance	$V_{DS} = 1000\text{ V}$		2.2		
C_{rss}	Reverse transfer capacitance	$f = 1\text{ MHz}$		0.15		
Q_g	Total gate charge	$V_{GS} = -5\text{ to }20\text{ V}$		1610		nC
Q_{gs}	Gate – source charge	$V_{BUS} = 800\text{ V}$		460		
Q_{gd}	Gate – drain charge	$I_D = 500\text{ A}$		500		
$T_{d(on)}$	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	$I_D = 500\text{ A}$		50		
T_f	Fall time	$R_L = 1.2\ \Omega$; $R_G = 0.3\ \Omega$		30		
E_{on}	Turn on energy	Inductive Switching $V_{GS} = -5\text{ to }20\text{ V}$		7.4		
E_{off}	Turn off energy	$T_j = 150\text{ }^\circ\text{C}$		4.8		
		$V_{BUS} = 600\text{ V}$				
		$I_D = 500\text{ A}$ $R_G = 0.3\ \Omega$				
R_{Gint}	Internal gate resistance			0.71		Ω
R_{thjc}	Junction-to-case thermal resistance				0.054	$^\circ\text{C/W}$

Table 4 • Body Diode Ratings and Characteristics

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	$V_{GS} = -5\text{ V}$ $T_j = 25\text{ }^\circ\text{C}$		4		V
		$I_{SD} = 250\text{ A}$ $T_j = 175\text{ }^\circ\text{C}$		3.5		
t_{rr}	Reverse recovery time	$I_{SD} = 500\text{ A}$; $V_{GS} = -5\text{ V}$		45		ns
Q_{rr}	Reverse recovery charge	$V_R = 800\text{ V}$; $di_r/dt = 10000\text{ A}/\mu\text{s}$		4		μC
I_{rr}	Reverse recovery current			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 Rr: Thermistor value at T

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

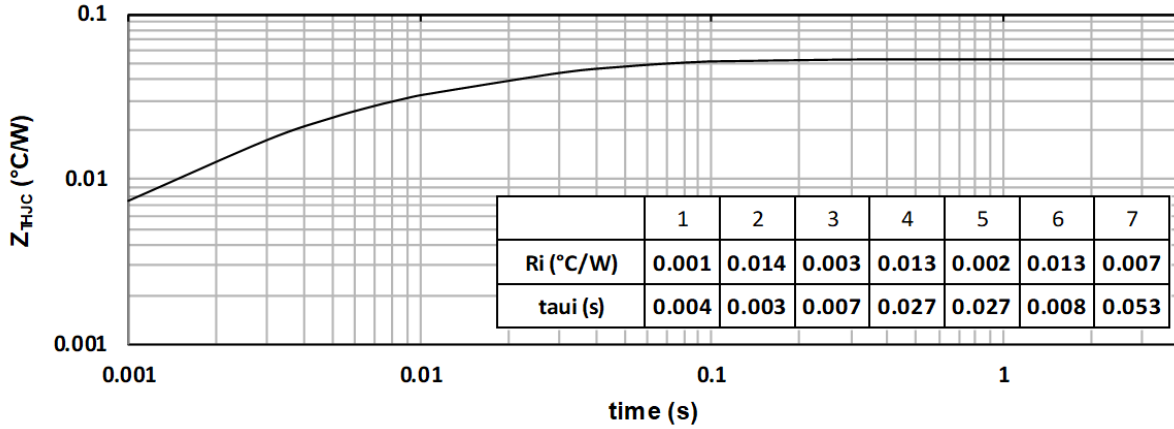


Figure 3 • Output Characteristics

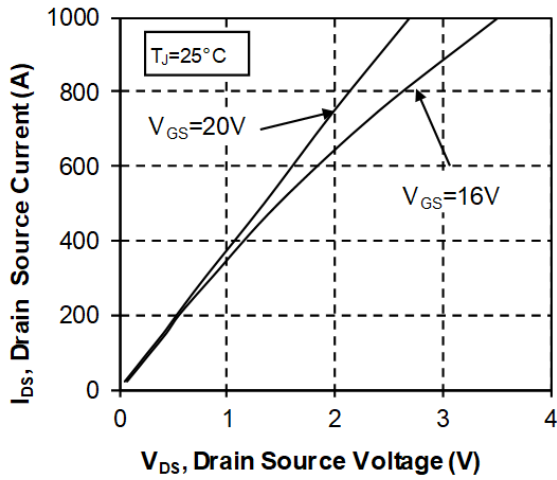


Figure 4 • Output Characteristics II

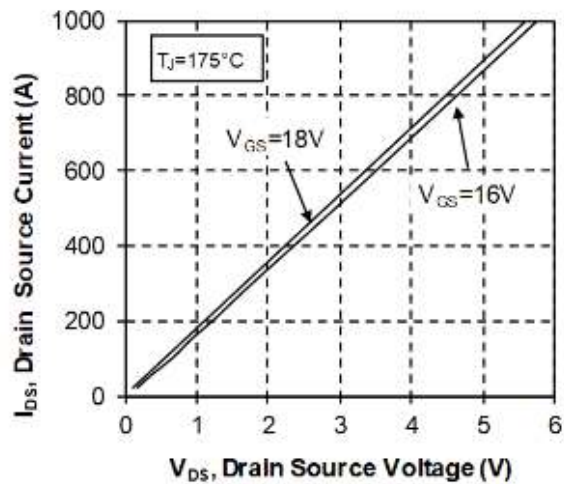


Figure 5 • Normalized RDS(on) vs. Temperature

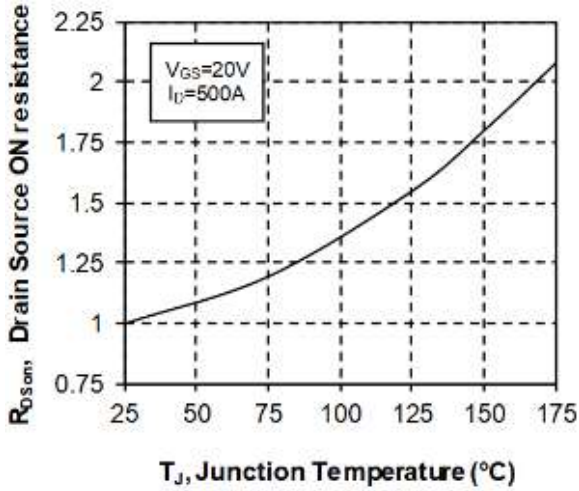


Figure 6 • Transfer Characteristics

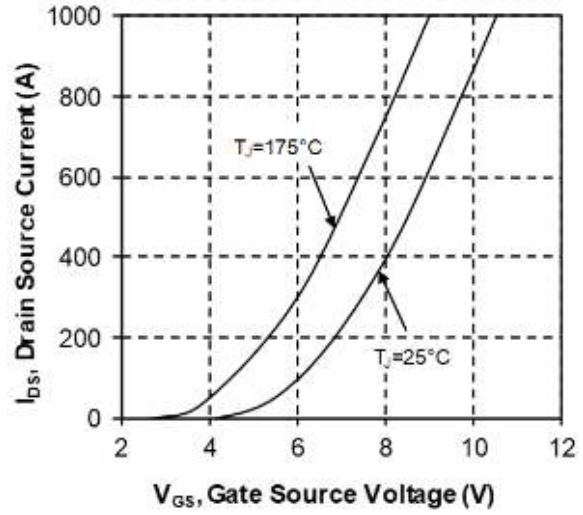


Figure 7 • Switching Energy vs. Rg

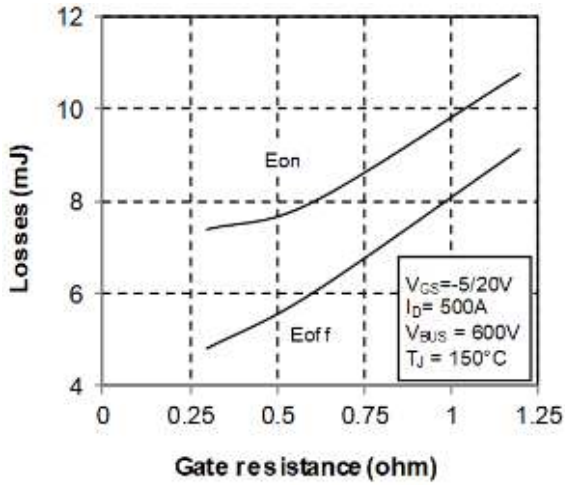


Figure 8 • Switching Energy vs. Current

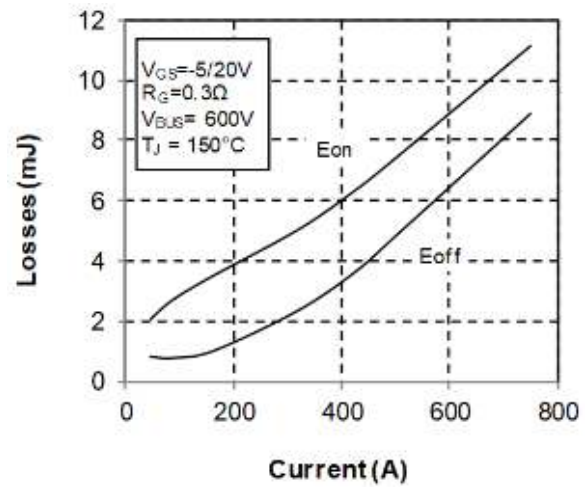


Figure 9 • Capacitance vs. Drain Source Voltage

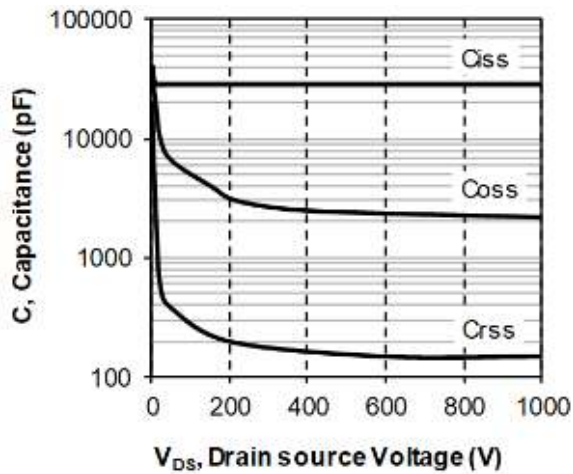


Figure 10 • Gate Charge vs. Gate Source Voltage

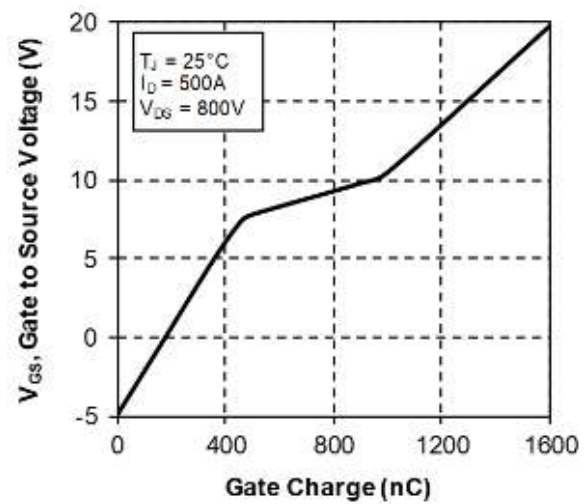


Figure 11 • Body Diode Characteristics

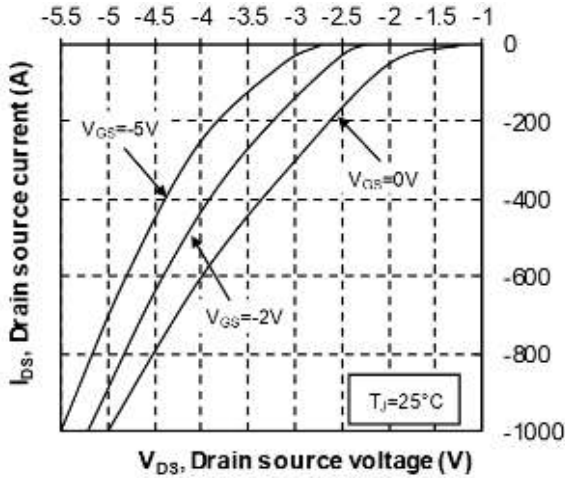


Figure 12 • 3rd Quadrant Characteristics

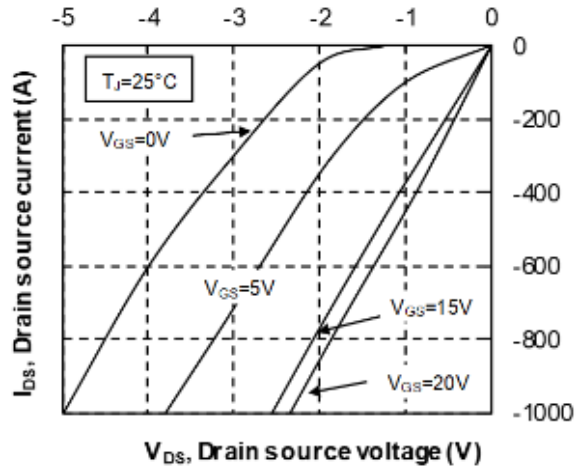


Figure 13 • Body Diode Characteristics II

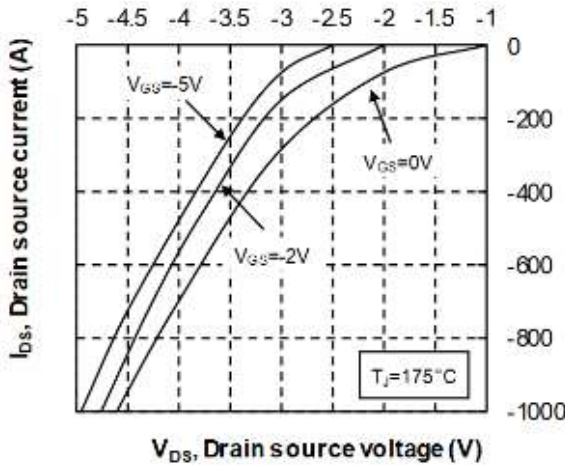


Figure 14 • 3rd Quadrant Characteristics

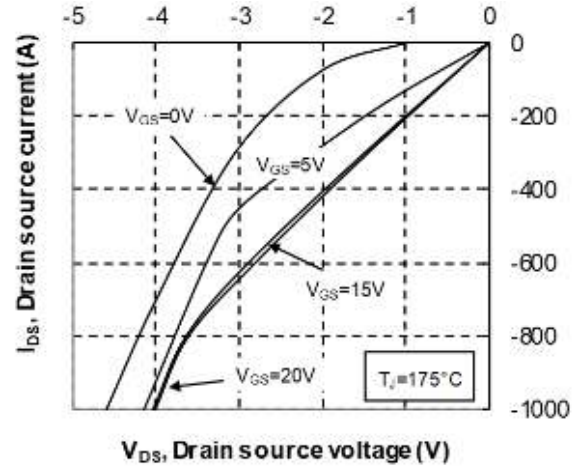
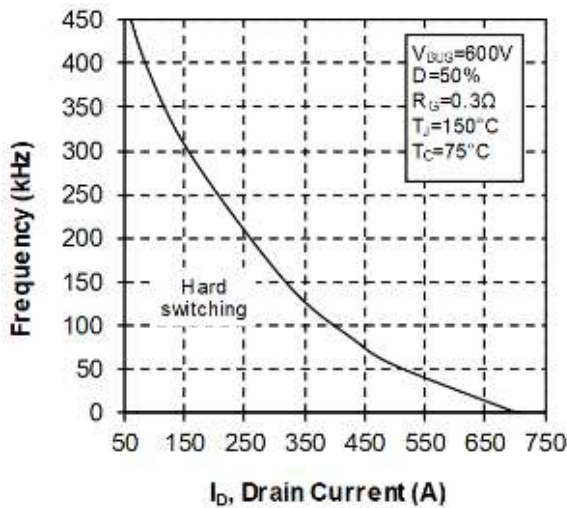


Figure 15 • Operating Frequency vs. Drain Current



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

Figure 16 • SiC Diode Maximum Thermal Impedance

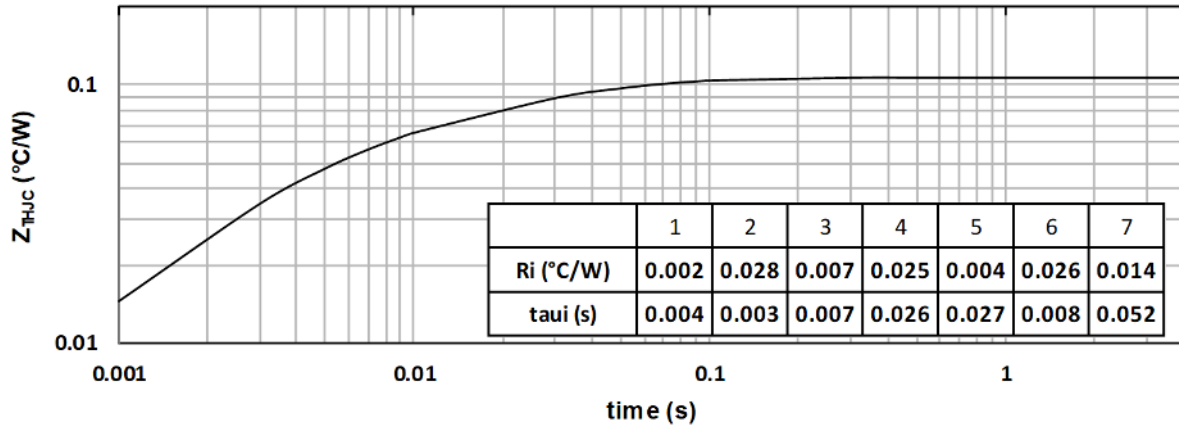


Figure 17 • Forward Characteristics

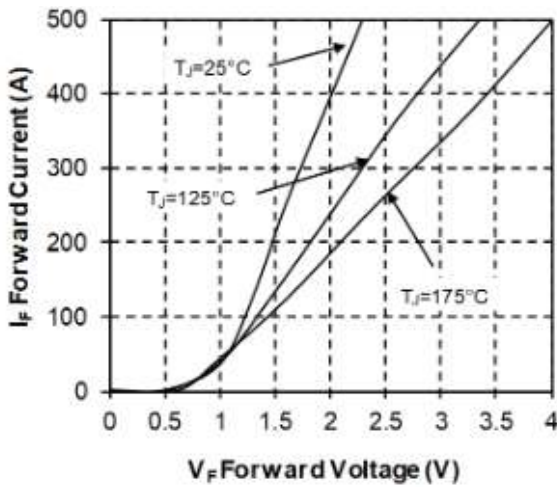


Figure 18 • Reverse Characteristics

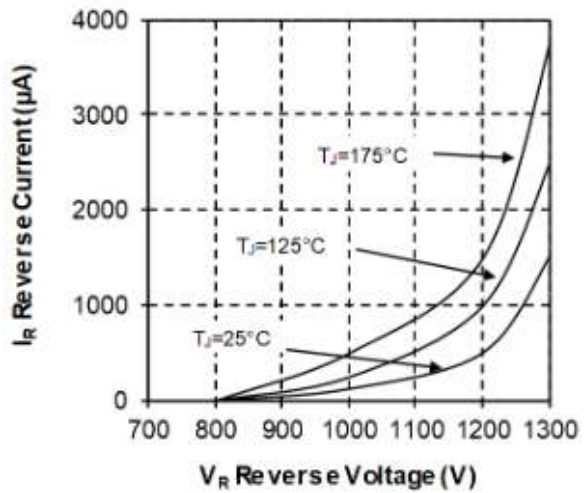
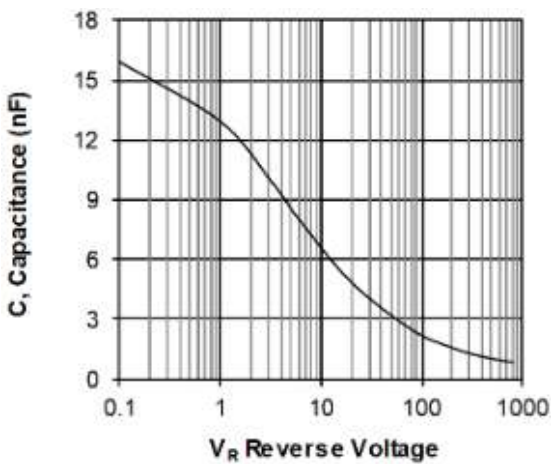


Figure 19 • Capacitance vs. Reverse Voltage



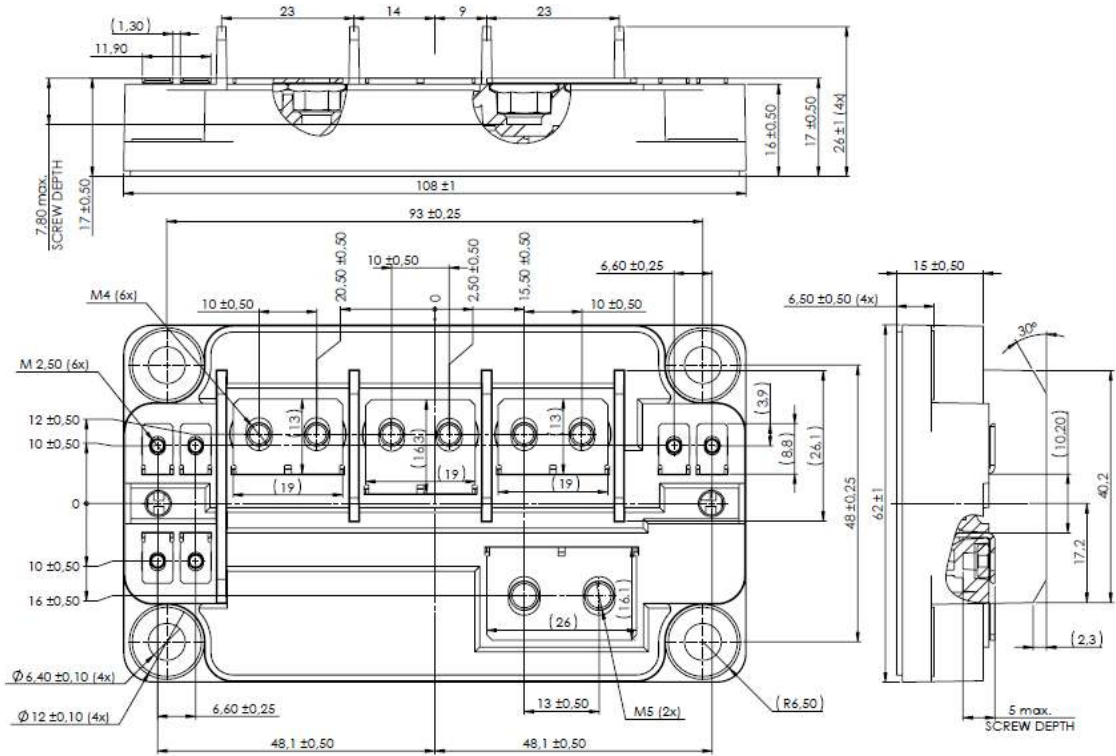
4 Package Specification

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.

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