

MSCMC120AM07CT6LIAG

Datasheet

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

Final

May 2018

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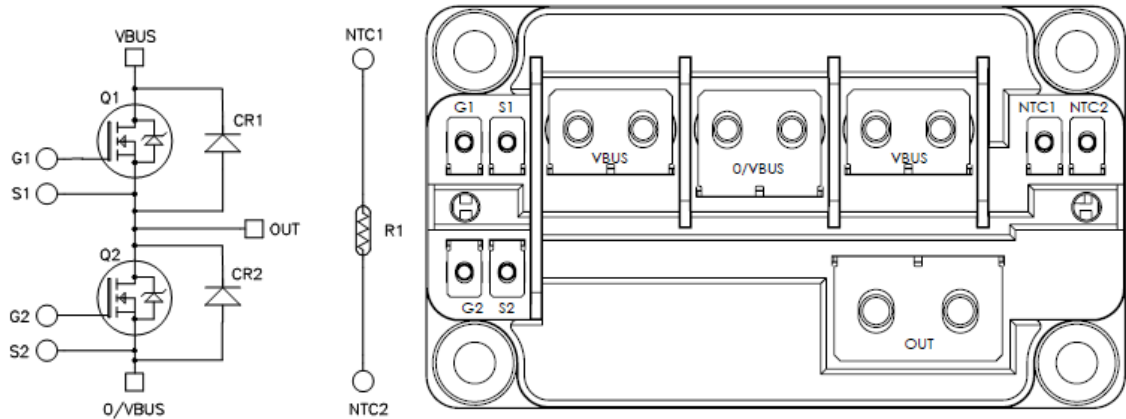
1 **Revision History**

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 MSCMC120AM07CT6LIAG 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 MSCMC120AM07CT6LIAG 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 MSCMC120AM07CT6LIAG device is designed for the following applications:

- Motor control

*All ratings taken at $T_J = 25^\circ\text{C}$ 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 MSCMC120AM07CT6LIAG device.

3.1 Absolute Maximum Ratings

The following table shows the SiC MOSFET absolute maximum ratings (per SiC MOSFET) for the MSCMC120AM07CT6LIAG device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter		Ratings	Unit
V_{DS}	Drain- source voltage		1200	V
I_D	Continuous drain current	$T_c = 25\text{ }^{\circ}\text{C}$	264	A
		$T_c = 80\text{ }^{\circ}\text{C}$	210	
I_{DM}	Pulsed drain current		530	
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		8.7	m Ω
P_D	Power dissipation	$T_c = 25\text{ }^{\circ}\text{C}$	1350	W

3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC120AM07CT6LIAG device.

Table 2 • Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I_{OSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 1200\text{ V}$		50	600	μA
$R_{DS(on)}$	Drain- source on resistance	$V_{GS} = 20\text{ V}$; $I_D = 240\text{ A}$		6.7	8.7	$\text{m}\Omega$
		$V_{GS} = 18\text{ V}$; $I_D = 240\text{ A}$		15		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$, $I_D = 60\text{ mA}$	2	2.6	4	V
I_{GSS}	Gate- source leakage current	$V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$			1.5	μA

Table 3 • Dynamic Characteristics

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$		11.4		nF
C_{oss}	Output capacitance	$V_{DS} = 1000\text{ V}$		0.9		
C_{rss}	Reverse transfer capacitance	$f = 1\text{ MHz}$		0.06		
Q_g	Total gate charge	$V_{GS} = -5\text{ to }20\text{ V}$		690		nC
Q_{gs}	Gate – source charge	$V_{Bus} = 800\text{ V}$		168		
Q_{gd}	Gate – drain charge	$I_D = 240\text{ A}$		222		
$T_{d(on)}$	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	$I_D = 240\text{ A}$		50		
T_f	Fall time	$R_L = 2.5\text{ }\Omega$; $R_G = 0.75\text{ }\Omega$		30		
E_{on}	Turn on energy	Inductive Switching $V_{GS} = -5\text{ to }20\text{ V}$		3		mJ
E_{off}	Turn off energy	$V_{Bus} = 600\text{ V}$ $I_D = 200\text{ A}$ $R_G = 0.75\text{ }\Omega$		2		
R_{Gint}	Internal gate resistance			1		Ω
R_{thJC}	Junction-to-case thermal resistance				0.111	$^{\circ}\text{C/W}$

Table 4 • Body Diode Ratings and Characteristics

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	$V_{GS} = -5\text{ V}$		4.1		V
		$I_{SD} = 120\text{ A}$		3.5		
t_{rr}	Reverse recovery time	$I_{SD} = 120\text{ A}$; $V_{GS} = -5\text{ V}$		54		ns

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
Q_{rr}	Reverse recovery charge	$V_R = 800\text{ V}$; $di_F/dt = 6000\text{ A}/\mu\text{s}$		1.7		μC
I_{rr}	Reverse recovery current			90		A

The following table shows the SiC diode characteristics (per SiC diode) of the MSCMC120AM07CT6LIAG 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	$V_R = 1200\text{ V}$		0.2	1.2	mA
		$T_J = 25\text{ }^\circ\text{C}$				
		$T_J = 175\text{ }^\circ\text{C}$		0.4	2.4	
I_F	DC forward current	$T_c = 95\text{ }^\circ\text{C}$		120		A
V_F	Diode forward voltage	$I_F = 120\text{ A}$		1.5	1.8	V
		$T_J = 25\text{ }^\circ\text{C}$				
		$T_J = 175\text{ }^\circ\text{C}$		2.2	3	
Q_C	Total capacitive charge	$V_R = 800\text{ V}$		594		nC
C	Total capacitance	$f = 1\text{ MHz}$, $V_R = 400\text{ V}$		558		pF
		$f = 1\text{ MHz}$, $V_R = 800\text{ V}$		402		
R_{thJC}	Junction-to-case thermal resistance				0.214	$^\circ\text{C}/\text{W}$

The following tables show the thermal and package characteristics of the MSCMC120AM07CT6LIAG device.

Table 6 • Package Characteristics

Symbol	Characteristic			Min	Max	Unit
V _{ISOL}	RMS isolation voltage, any terminal to case t =1 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 _{Jmax} −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	N.m
			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
ΔR ₂₅ /R ₂₅			5		%
B _{25/85}	T ₂₅ = 298.15 K		3952		K
ΔB/B	T _c = 100 °C		4		%

Note: See application note APT0406 on 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 MSCMC120AM07CT6LIAG device.

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

Figure 2 • Maximum Thermal Impedance

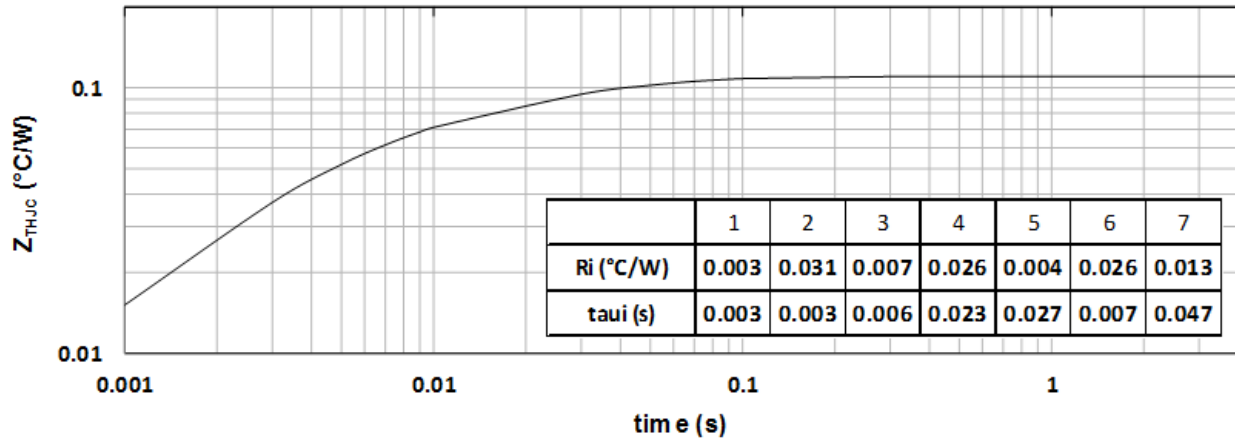


Figure 3 • Output Characteristics

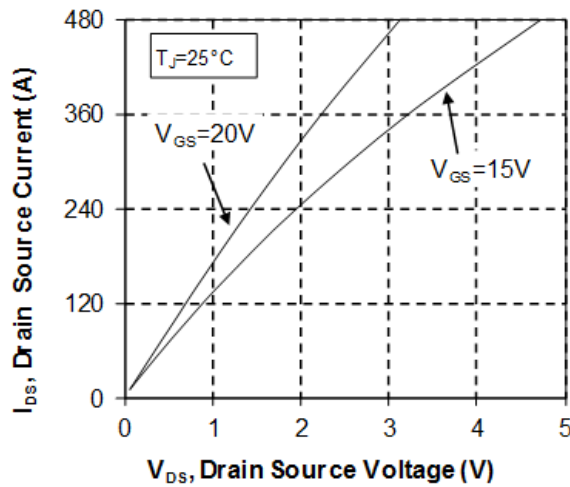


Figure 4 • Output Characteristics II

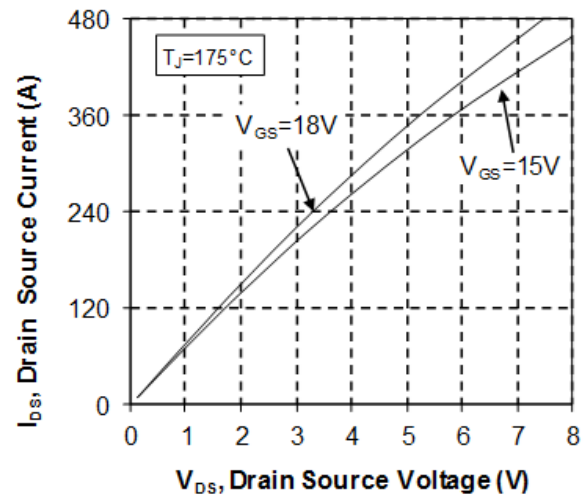


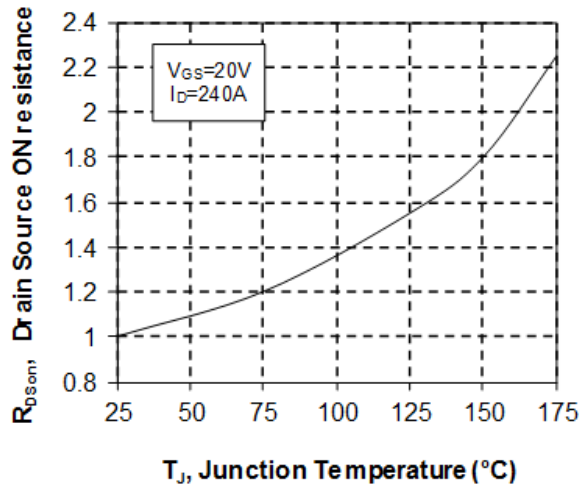
Figure 5 • Normalized $R_{DS(on)}$ vs. Temperature

Figure 6 • Transfer Characteristics

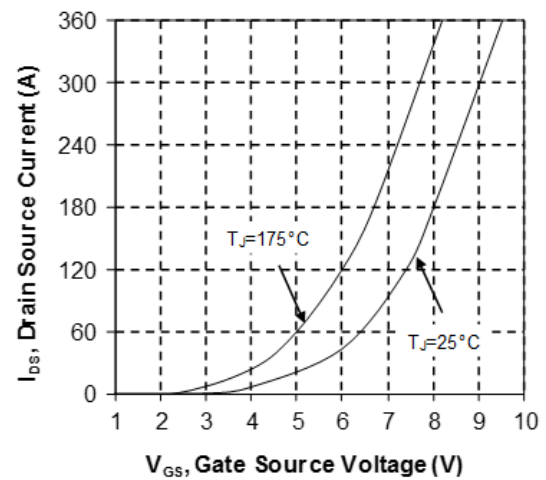
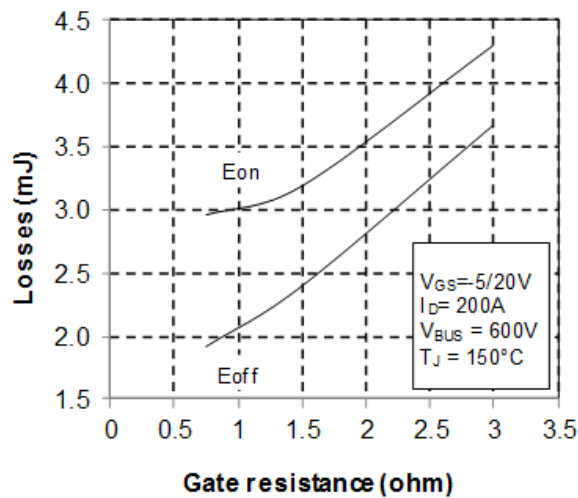
Figure 7 • Switching Energy vs. R_g 

Figure 8 • Switching Energy vs. Current

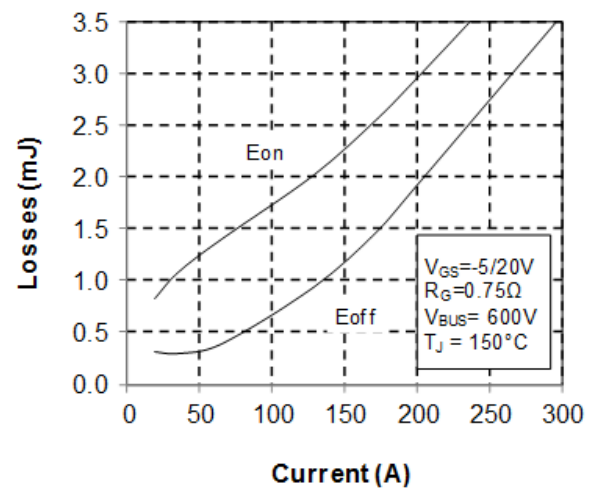


Figure 9 • Capacitance vs. Drain Source Voltage

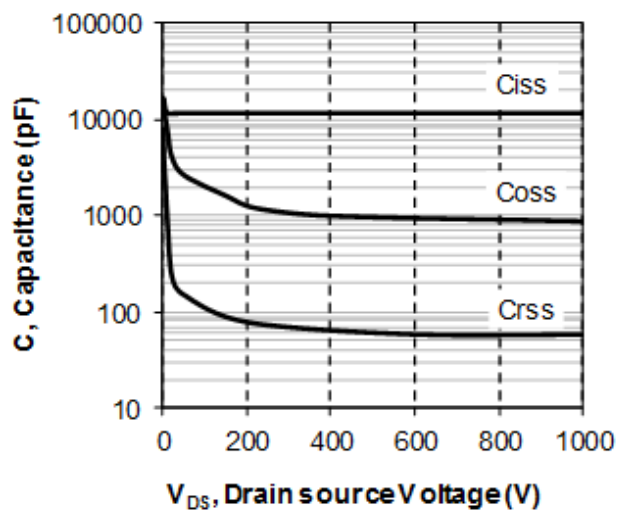


Figure 10 • Gate Charge vs. Gate Source Voltage

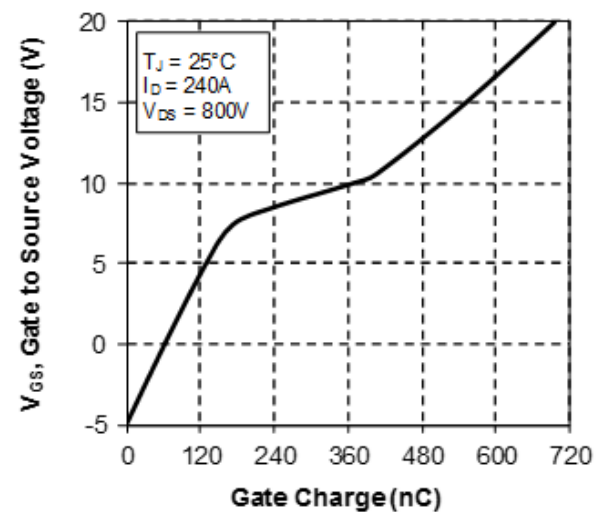


Figure 11 • Body Diode Characteristics

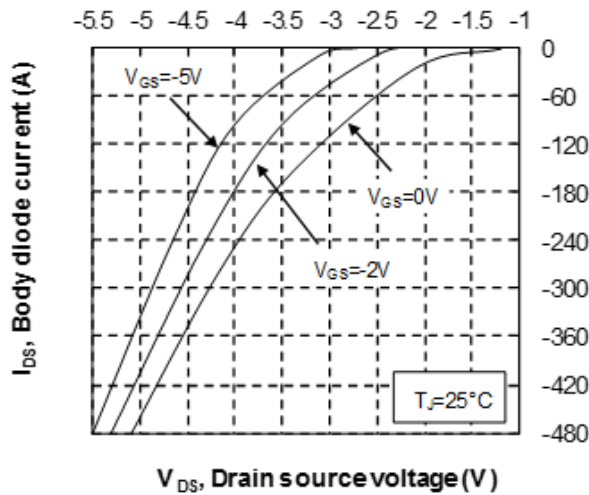


Figure 12 • 3rd Quadrant Characteristics

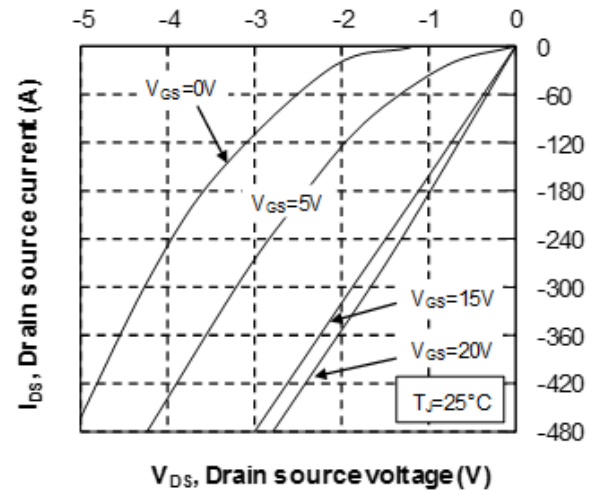


Figure 13 • Body Diode Characteristics II

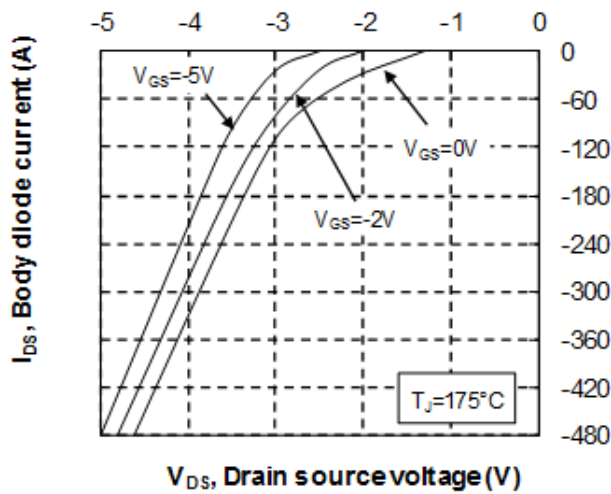


Figure 14 • 3rd Quadrant Characteristics

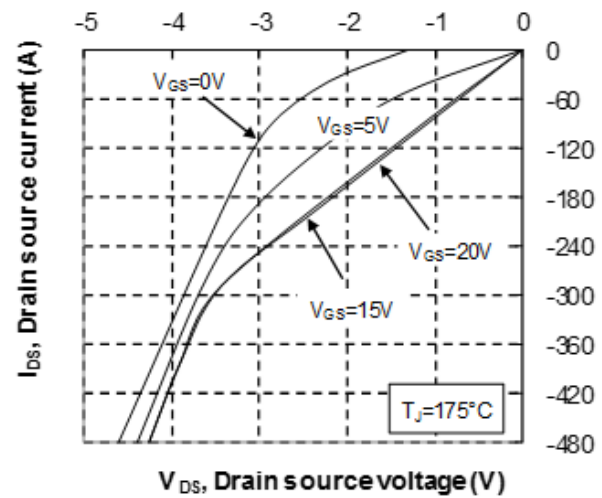
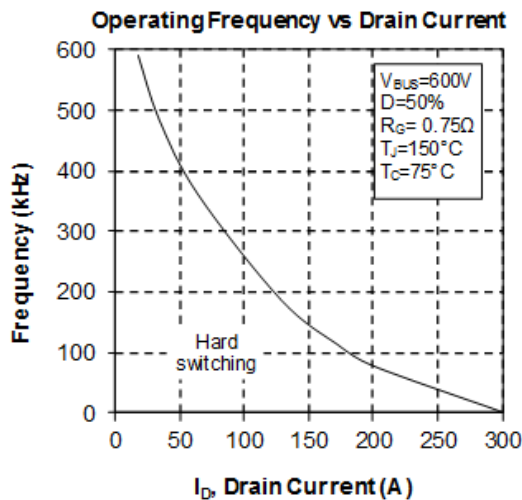


Figure 15 • Operating Frequency vs. Drain Current



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

Figure 16 • SiC Diode Maximum Thermal Impedance

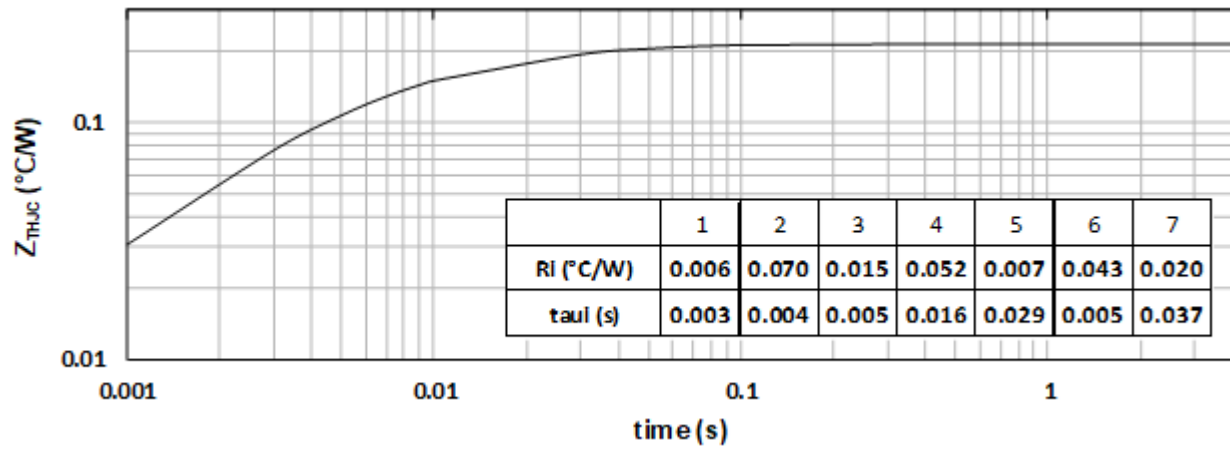


Figure 17 • Forward Characteristics

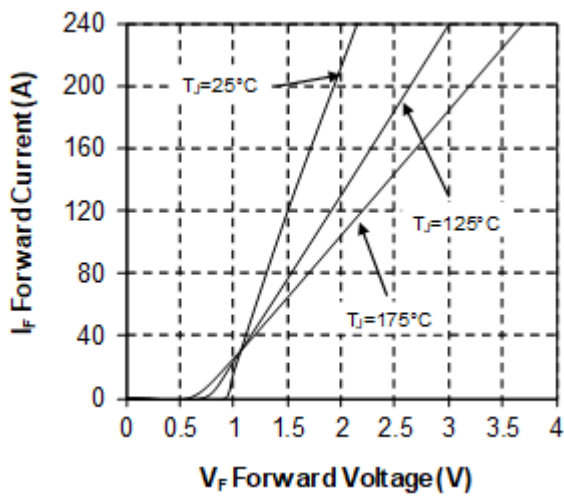


Figure 18 • Reverse Characteristics

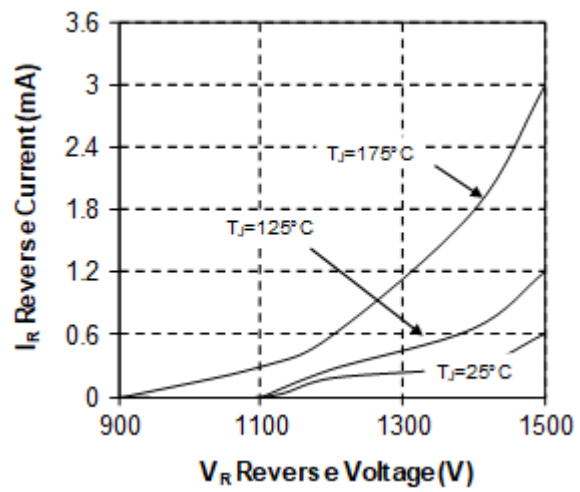
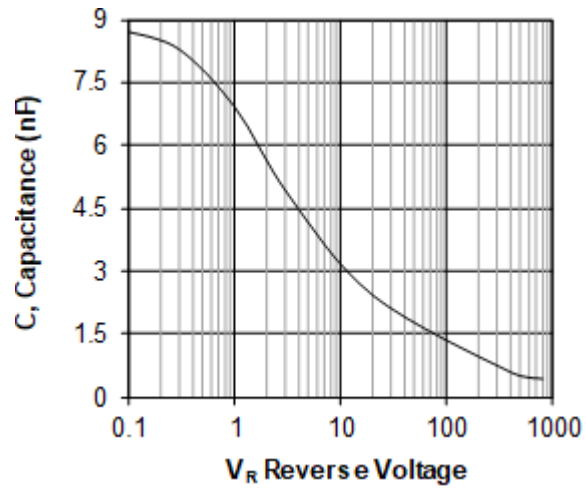


Figure 19 • Capacitance vs. Reverse Voltage

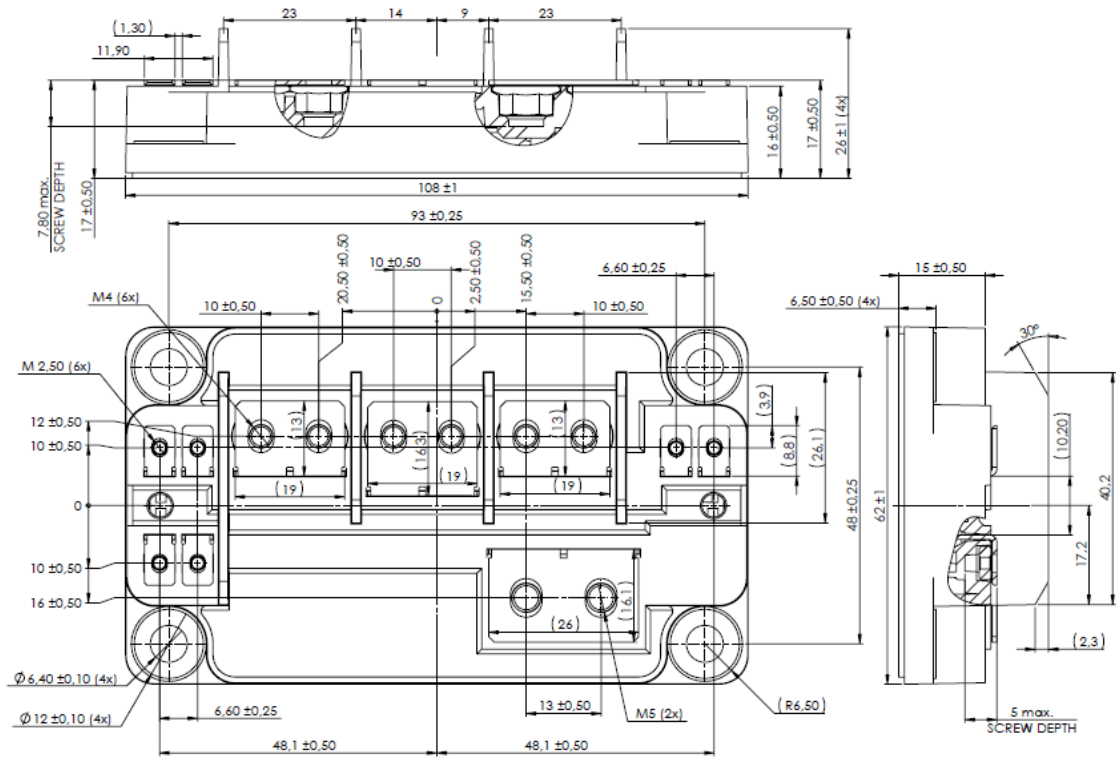
4 Package Specification

This section outlines the package specification for the MSCMC120AM07CT6LIAG device.

4.1 Package Outline Drawing

This section details the package drawing of the MSCMC120AM07CT6LIAG 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

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