MSCMC170AM08CT6LIAG

Datasheet

Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

Final

May 2018

Microsemi

Power Matters.™

Contents

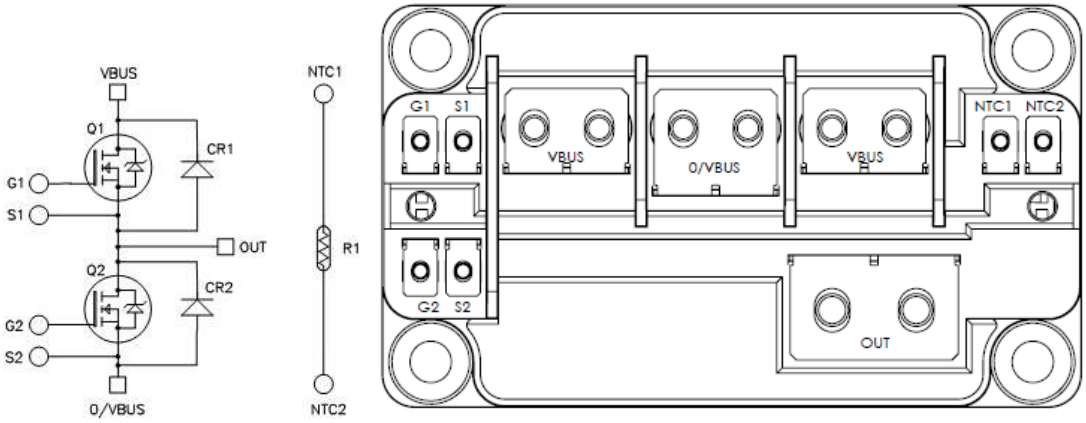
1 Revision History

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 MSCMC170AM08CT6LIAG device:

- Very low stray inductance
- Internal thermistor for temperature monitoring
- M4 and M5 power connectors
- M2.5 signal connectors
- AIN 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 the benefits of the MSCMC170AM08CT6LIAG 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 MSCMC170AM08CT6LIAG device is designed for the following applications:

- Motor control

*All ratings taken at T_j = 25 °C unless otherwise specified.

Caution: These devices are sensitive to electrostatic discharge. Proper handling procedures should be followed.

3 Electrical Specifications

This section details the electrical specifications for the MSCMC170AM08CT6LIAG device.

3.1 Absolute Maximum Ratings

The following table shows the SiC MOSFET absolute maximum ratings (per SiC MOSFET) for the MSCMC170AM08CT6LIAG device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter		Max Ratings	Unit
V_{DSS}	Drain-source voltage		1700	V
I_D	Continuous drain current	T_C = 25 °C	280	A
		T_C = 80 °C	207	
I_{DM}	Pulsed drain current		560	
V_{GS}	Gate-source voltage		–5 to 23	V
V_{GSOP}	Gate-source voltage; recommended operation values		–5 to 18	
R_{DSon}	Drain-source ON resistance		11.7	mΩ
P_D	Power dissipation	T_C = 25 °C	1780	W

3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC170AM08CT6LIAG device.

Table 2 • Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 1700 V			60	600	µA
$R_{DS(on)}$	Drain-source on resistance	V_{GS} = 20 V, I_D = 300 A	T_j = 25 °C		7.5	11.7	mΩ
		V_{GS} = 18 V, I_D = 300 A	T_j = 150 °C		15		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 108 mA		2	2.4	4	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				3.6	µA

Table 3 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		22		nF
C_{oss}	Output capacitance	V_{DS} = 1000 V		1.03		
C_{rss}	Reverse transfer capacitance	f = 1 MHz		0.04		
Q_g	Total gate charge	V_{GS} = –5 to 20 V		1128		nC
Q_{gs}	Gate–source charge	V_{Bus} = 1200 V		264		
Q_{gd}	Gate–drain charge	I_D = 300 A		342		
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5 to 20 V		105		ns

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
T_r	Rise time	V_{Bus} = 900 V			75		
$T_{d(off)}$	Turn-off delay time	I_D = 300 A			210		
T_f	Fall time	R_G = 3.3 Ω			55		
E_{on}	Turn on energy	Inductive switching	T_j = 150 °C		13.2		mJ
E_{off}	Turn off energy	V_{GS} = –5 to 20 V V_{Bus} = 900 V I_D = 300 A R_G = 3.3 Ω	T_j = 150 °C		9		
R_{Gint}	Internal gate resistance				0.9		Ω
R_{thJC}	Junction-to-case thermal resistance					0.07	°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 V I_{SD} = 150 A	T_j = 25 °C		4.1		V
			T_j = 150 °C		3.6		
t_{rr}	Reverse recovery time	I_{SD} = 300 A			70		ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5V			3.2		µC
I_{rr}	Reverse recovery current	V_R = 1200 V di_F/dt = 8400 A/µs			84		A

The following table shows the SiC diode characteristics of the MSCMC170AM08CT6LIAG device (per SiC diode).

Table 5 • SiC Diode Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage					1700	V
I_{RM}	Reverse leakage current	V_R = 1700 V	T_j = 25 °C		0.48	3	mA
			T_j = 175 °C		1	6.4	
I_F	DC forward current		Tc = 125 °C		200		A
V_F	Diode forward voltage	I_F = 200A	T_j = 25 °C		1.6	1.9	V
			T_j = 175 °C		2.5	2.8	
Q_C	Total capacitive charge	V_R = 1100 V			1480		nC
C	Total capacitance	f = 1 MHz, V_R = 400 V			960		pF
		f = 1 MHz, V_R = 800 V			936		
R_{thJC}	Junction-to-case thermal resistance					0.086	°C/W

The following tables show the thermal and package characteristics of the MSCMC170AM08CT6LIAG 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	SiC MOSFET		–40	150	°C
		SiC diode		–40	175	
T_{JOP}	Recommended junction temperature under switching conditions			–40	$T_J$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	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		k Ω
$\Delta R_{25}/R_{25}$			5		%
$B_{25/85}$	T_{25} = 298.15 K		3952		K
ΔB/B	T_C=100 °C		4		%

Note: See the APT0406 Application Note at www.microsemi.com.

Figure 1 • NTC Formula

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

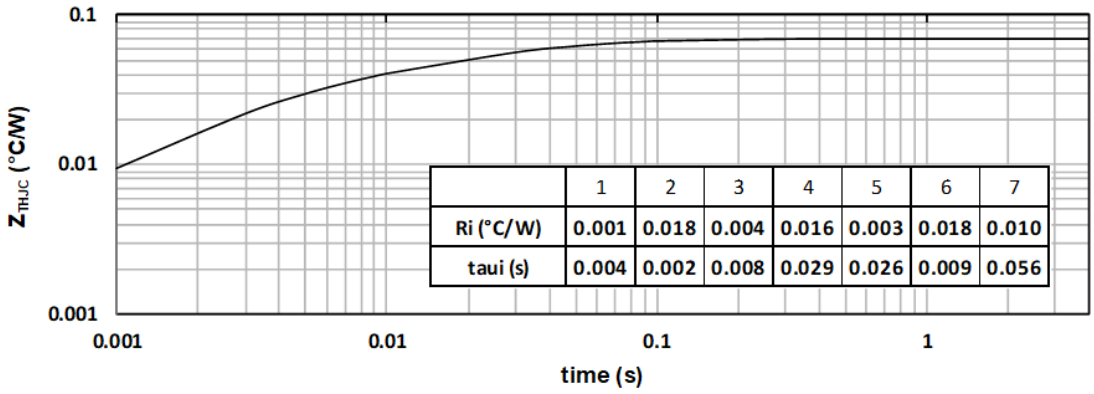
T: thermistor temperature R_T: thermistor value at T

3.3 Typical Performance Curves

This section shows the typical performance curves for the MSCMC170AM08CT6LIAG device.

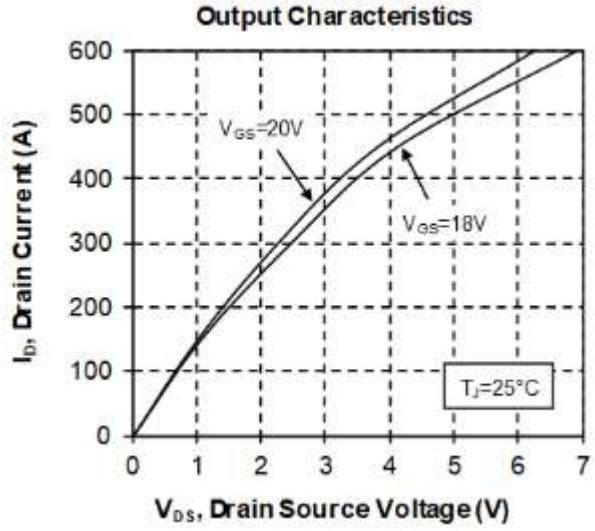
The following section details the typical performance curves for the SiC MOSFET.

Maximum thermal impedance

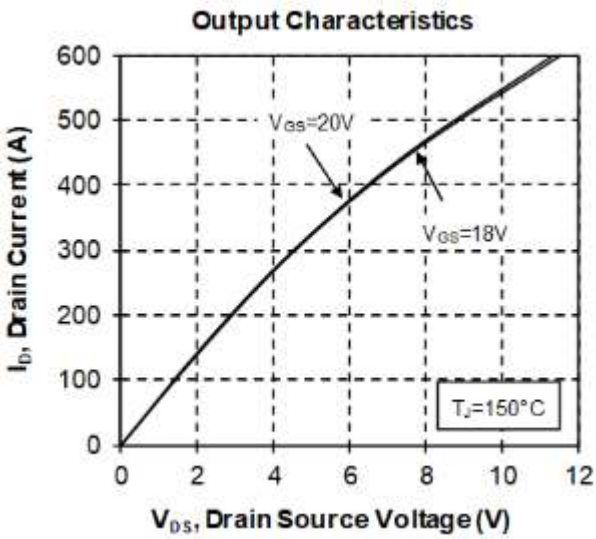


	1	2	3	4	5	6	7
Ri (°C/W)	0.001	0.018	0.004	0.016	0.003	0.018	0.010
taui (s)	0.004	0.002	0.008	0.029	0.026	0.009	0.056

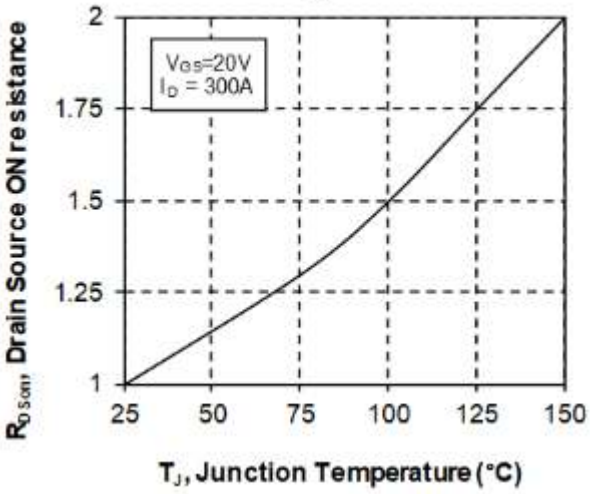
Output Characteristics



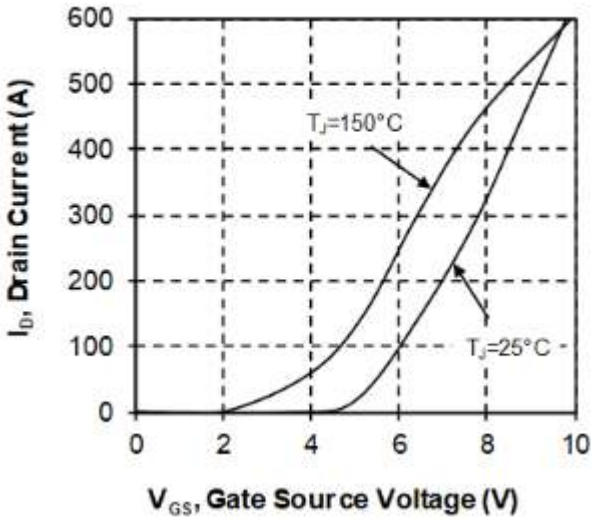
Output Characteristics



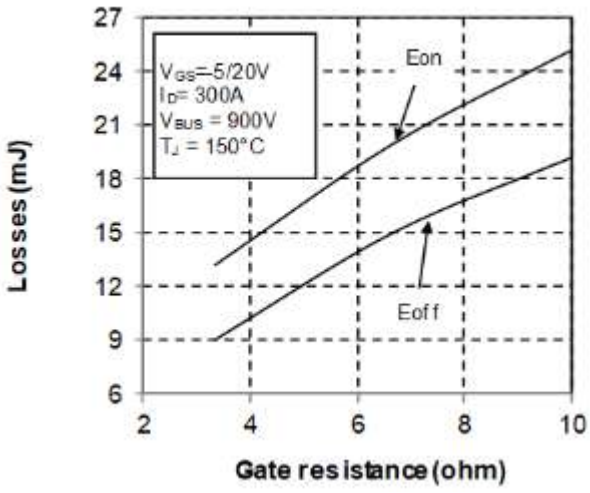
Normalized $R_{DS(on)}$ vs. Temperature



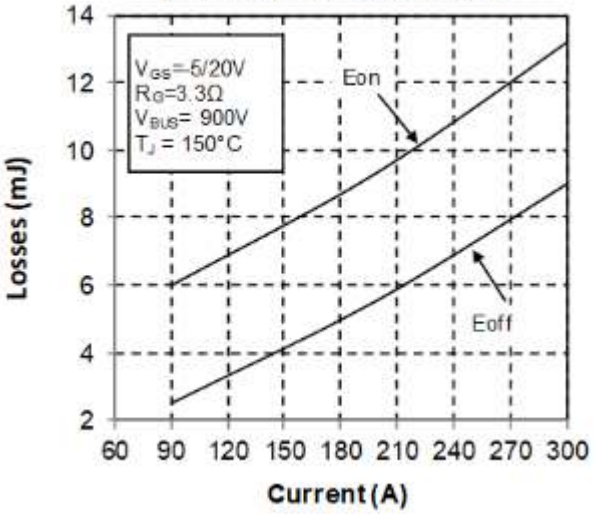
Transfert Characteristics



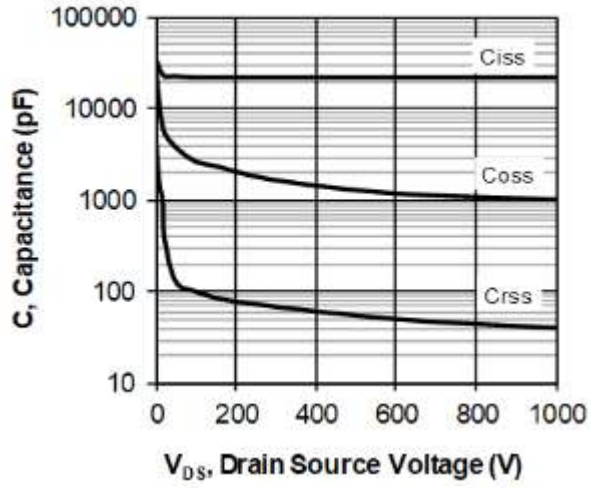
Switching energy vs Rg



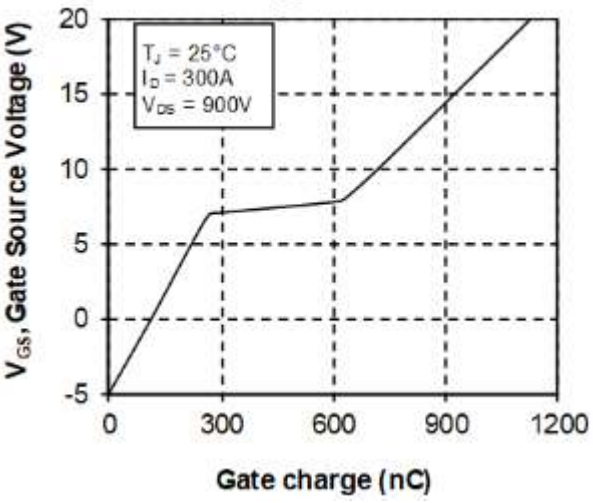
Switching energy vs current

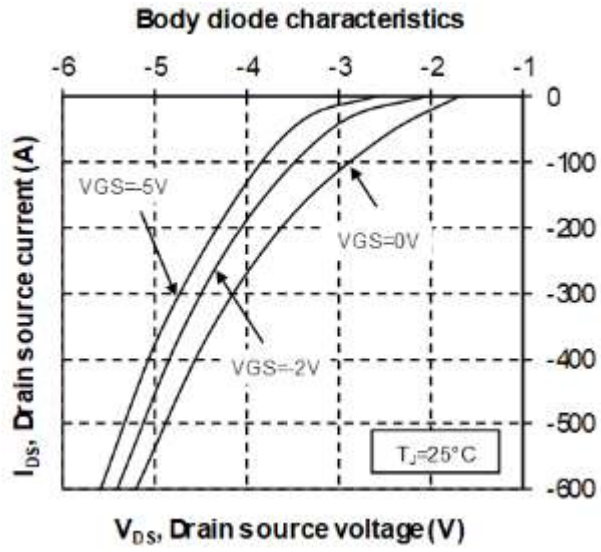


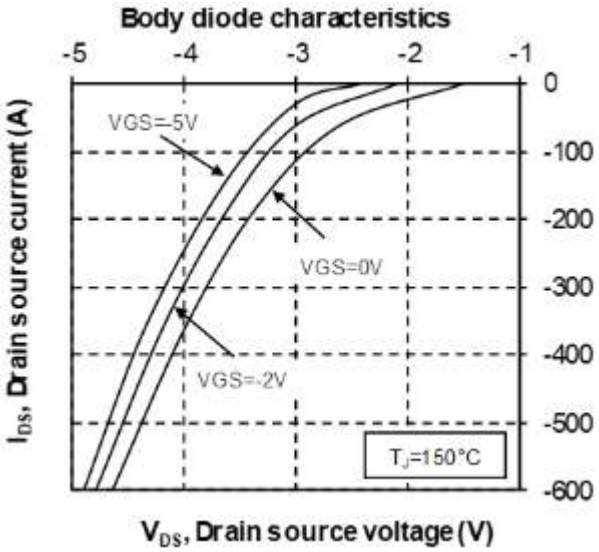
Capacitance vs Drain to Source Voltage

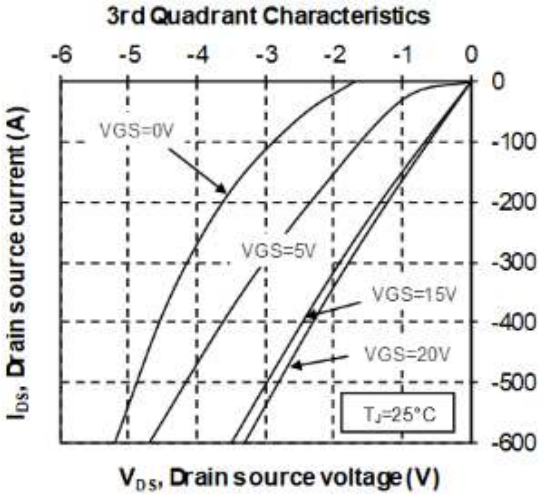


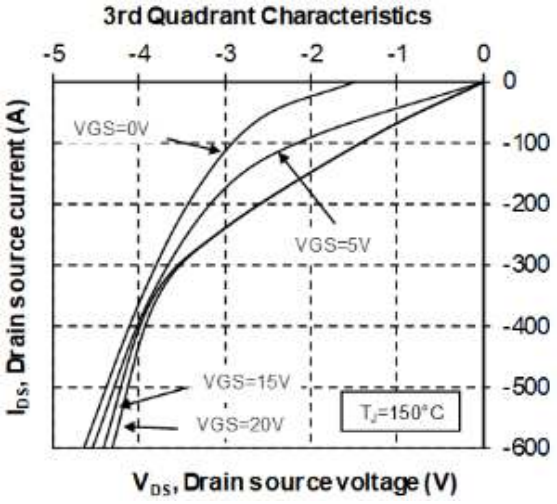
Gate charge characteristics

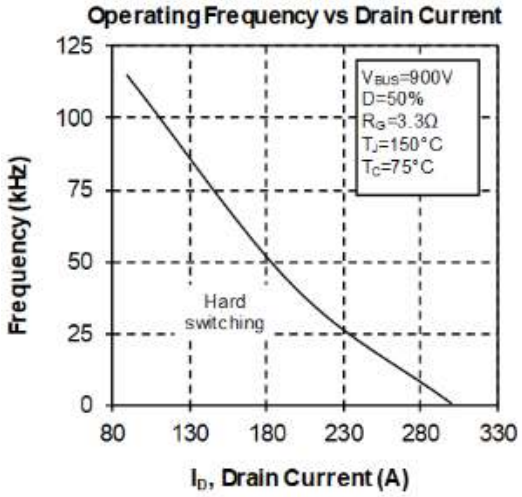



Body diode characteristics
-6 -5 -4 -3 -2 -1
0 -100 -200 -300 -400 -500 -600
VGS=-5V
VGS=0V
VGS=-2V
TJ=25°C
IDS, Drain source current (A)
VDS, Drain source voltage (V)


Body diode characteristics
-5 -4 -3 -2 -1
0 -100 -200 -300 -400 -500 -600
VGS=-5V
VGS=0V
VGS=-2V
TJ=150°C
IDS, Drain source current (A)
VDS, Drain source voltage (V)

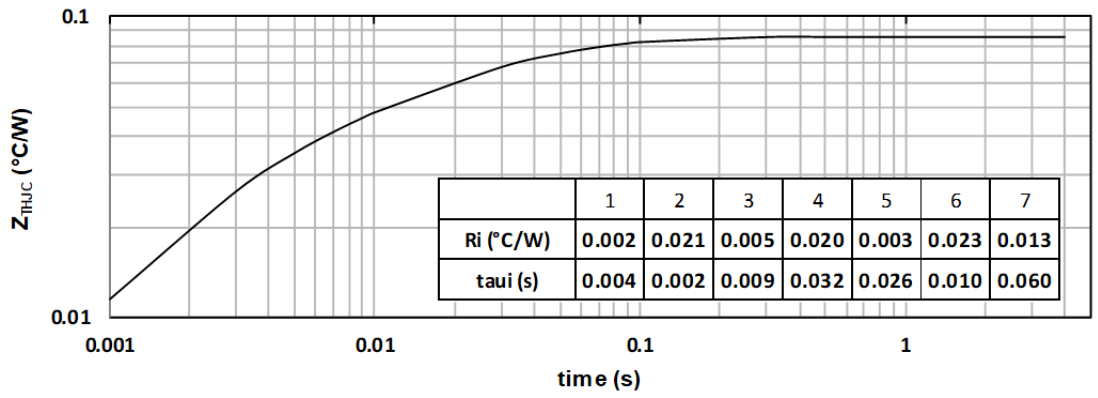

3rd Quadrant Characteristics
-6 -5 -4 -3 -2 -1 0
0 -100 -200 -300 -400 -500 -600
VGS=0V
VGS=5V
VGS=15V
VGS=20V
TJ=25°C
IDS, Drain source current (A)
VDS, Drain source voltage (V)


3rd Quadrant Characteristics
-5 -4 -3 -2 -1 0
0 -100 -200 -300 -400 -500 -600
VGS=0V
VGS=5V
VGS=15V
VGS=20V
TJ=150°C
IDS, Drain source current (A)
VDS, Drain source voltage (V)


Operating Frequency vs Drain Current
125
100
75
50
25
0
80 130 180 230 280 330
VBUS=900V
D=50%
RG=3.3Ω
TJ=150°C
TC=75°C
Hard switching
Frequency (kHz)
ID, Drain Current (A)

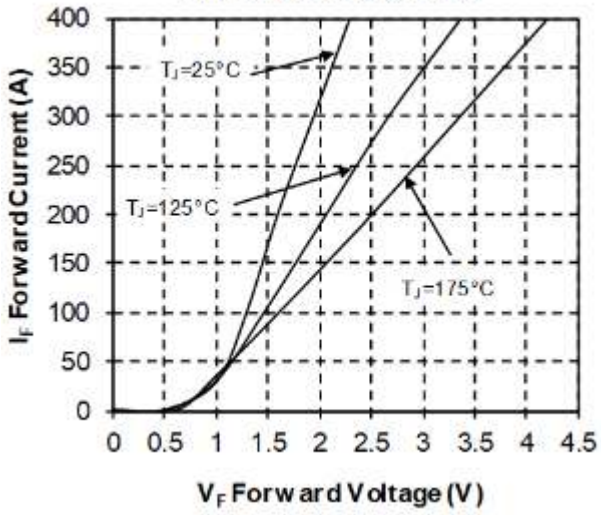
The following section details the typical performance curves for the SiC Diode.

Maximum thermal impedance

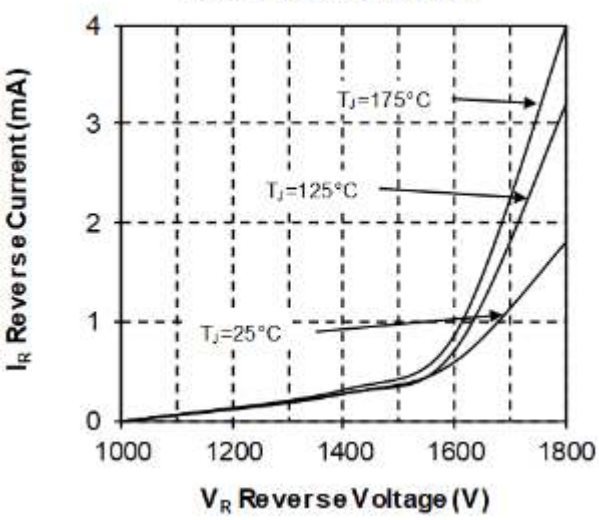


	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.021	0.005	0.020	0.003	0.023	0.013
taui (s)	0.004	0.002	0.009	0.032	0.026	0.010	0.060

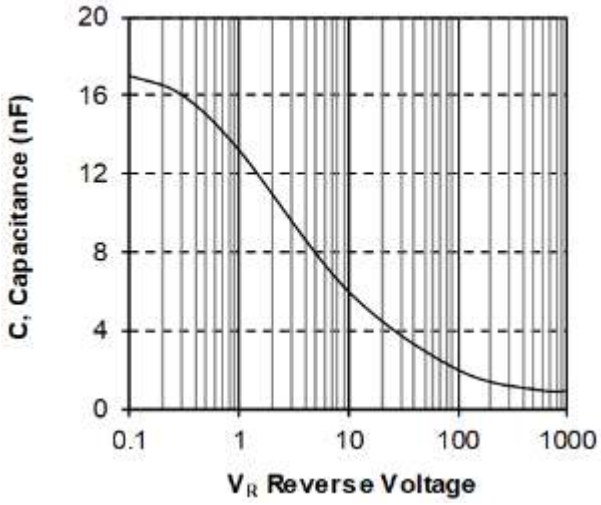
Forward Characteristics



Reverse Characteristics



Capacitance vs.Reverse Voltage

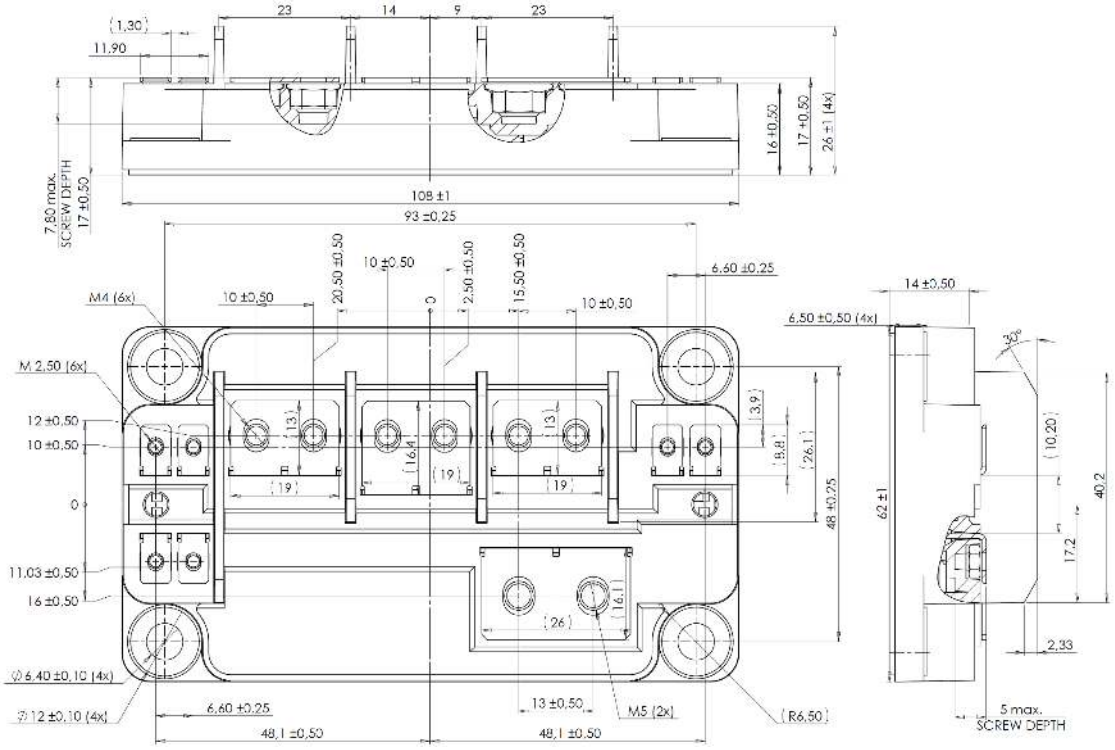


4 Package Specification

This section outlines the package specification for the MSCMC170AM08CT6LIAG device.

4.1 Package Outline Drawing

Figure 2 • Package Outline (Dimensions in mm)



See application note AN1911 - Mounting Instructions for SP6 Low Inductance Power Module at www.microsemi.com

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