

**MSCSM120AM03CT6LIAG**

**Datasheet**

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

January 2020



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a  **MICROCHIP** company

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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.

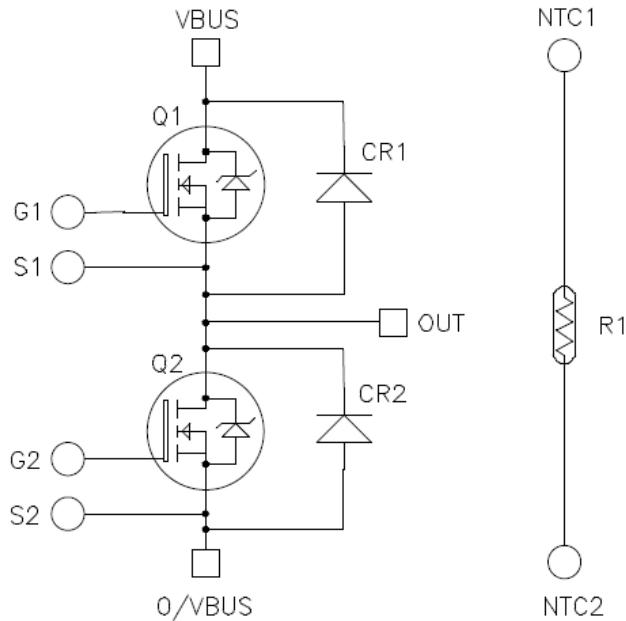
## 1.1 Revision 1.0

Revision 1.0 was published in January 2020. It is the first publication of this document.

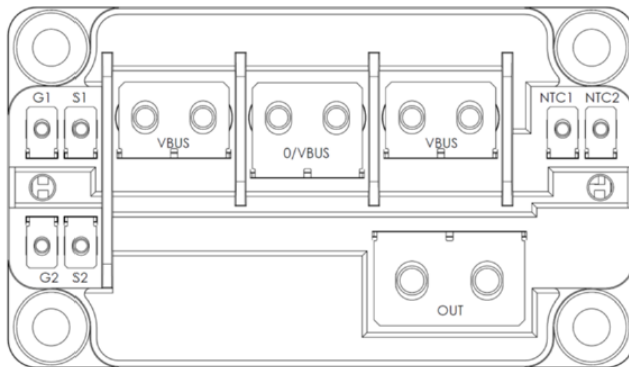
## 2 Product Overview

The MSCSM120AM03CT6LIAG device is a 1200 V, 805 A full Silicon Carbide power module.

**Figure 1 • Electrical Schematic of MSCSM120AM03CT6LIAG Device**



**Figure 2 • Pinout Location**



All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified.

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

## 2.1 Features

The following are the features of MSCSM120AM03CT6LIAG device:

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

## 2.2 Benefits

The following are the benefits of MSCSM120AM03CT6LIAG device:

- High efficiency converter
- 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 following are the applications of MSCSM120AM03CT6LIAG device:

- Welding converters
- Switched mode power supplies
- Uninterruptible power supplies
- EV motor and traction drive

## 3 Electrical Specifications

This section provides the electrical specifications for the MSCSM120AM03CT6LIAG device.

### 3.1 SiC MOSFET Characteristics (Per MOSFET)

The following table shows the absolute maximum ratings of MSCSM120AM03CT6LIAG device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameters	Maximum Ratings	Unit	
$V_{DSS}$	Drain–source voltage	1200	V	
$I_D$	Continuous drain current	$T_C = 25^\circ\text{C}$	805 <sup>1</sup>	A
		$T_C = 80^\circ\text{C}$	640 <sup>1</sup>	
$I_{DM}$	Pulsed drain current	1600		
$V_{GS}$	Gate–source voltage	–10/25	V	
$R_{DS(on)}$	Drain–source ON resistance	3.1	m $\Omega$	
$P_D$	Power dissipation	$T_C = 25^\circ\text{C}$	3215	W

**Note:**

1. Specification of SiC MOSFET device but output current must be limited due to size of power connectors.

The following table shows the electrical characteristics of MSCSM120AM03CT6LIAG device.

**Table 2 • Electrical Characteristics**

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 1200\text{ V}$		150	1000	$\mu\text{A}$
$R_{DS(on)}$	Drain–source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 400\text{ A}$	$T_C = 25^\circ\text{C}$	2.5	3.1	m $\Omega$
			$T_C = 175^\circ\text{C}$	4		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 10\text{ mA}$	1.8	2.8		V
$I_{GSS}$	Gate–source leakage current	$V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$			1	$\mu\text{A}$

The following table shows the dynamic characteristics of MSCSM120AM03CT6LIAG device.

**Table 3 • Dynamic Characteristics**

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$		30.2		nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$ $f = 1\text{ MHz}$		2.7		
$C_{rss}$	Reverse transfer capacitance			0.25		
$Q_g$	Total gate charge	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 800\text{ V}$ $I_D = 400\text{ A}$		2320		nC
$Q_{gs}$	Gate–source charge			410		
$Q_{gd}$	Gate–drain charge			500		
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5/20\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$		56		ns
$T_r$	Rise time	$V_{Bus} = 600\text{ V}$		55		
$T_{d(off)}$	Turn-off delay time	$I_D = 500\text{ A}$ $R_G = 0.3\ \Omega$		166		
$T_f$	Fall time			67		
$E_{on}$	Turn on energy	Inductive switching $T_J = 150\text{ }^\circ\text{C}$		9.2		mJ
$E_{off}$	Turn off energy	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 500\text{ A}$ $R_G = 0.3\ \Omega$		8.3		
$R_{Gint}$	Internal gate resistance			0.98		$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance				0.047	$^\circ\text{C/W}$

The following table shows the body diode ratings and characteristics of MSCSM120AM03CT6LIAG device.

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

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}$ ; $I_{SD} = 400\text{ A}$		4		V
		$V_{GS} = -5\text{ V}$ ; $I_{SD} = 400\text{ A}$		4.2		
$t_{rr}$	Reverse recovery time	$I_{SD} = 400\text{ A}$ ; $V_{GS} = -5\text{ V}$		90		ns
$Q_{rr}$	Reverse recovery charge	$V_R = 800\text{ V}$ ; $di_F/dt = 10000\text{ A}/\mu\text{s}$		5.5		$\mu\text{C}$
$I_{rr}$	Reverse recovery current			135		A

### 3.2 SiC Diode Characteristics (Per SiC Diode)

The following table shows the SiC diode characteristics (per SiC diode) of MSCSM120AM03CT6LIAG 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	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$	0.08	1	mA
			$T_J = 175\text{ °C}$	1.25		
$I_F$	DC forward current		$T_C = 95\text{ °C}$	250		A
$V_F$	Diode forward voltage	$I_F = 250\text{ A}$	$T_J = 25\text{ °C}$	1.5	1.8	V
			$T_J = 175\text{ °C}$	2.1		
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$		1120		nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$		1230		pF
		$f = 1\text{ MHz}, V_R = 800\text{ V}$		910		
$R_{thJC}$	Junction-to-case thermal resistance				0.126	°C/W



### 3.3 Thermal and Package Characteristics

The following table shows the package characteristics of MSCSM120AM03CT6LIAG device.

**Table 6 • Package Characteristics**

Symbol	Characteristics		Min	Max	Unit	
V <sub>ISOL</sub>	RMS isolation voltage, any terminal to case t =1 min, 50/60 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 V <sub>BUS</sub> and 0/V <sub>BUS</sub>			3	nH	
Wt	Package weight			320	g	

The following table shows the temperature sensor NTC of MSCSM120AM03CT6LIAG device.

**Table 7 • Temperature Sensor NTC**

Symbol	Characteristics		Min	Typ	Max	Unit
R <sub>25</sub>	Resistance at 25°C			50		kΩ
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		%

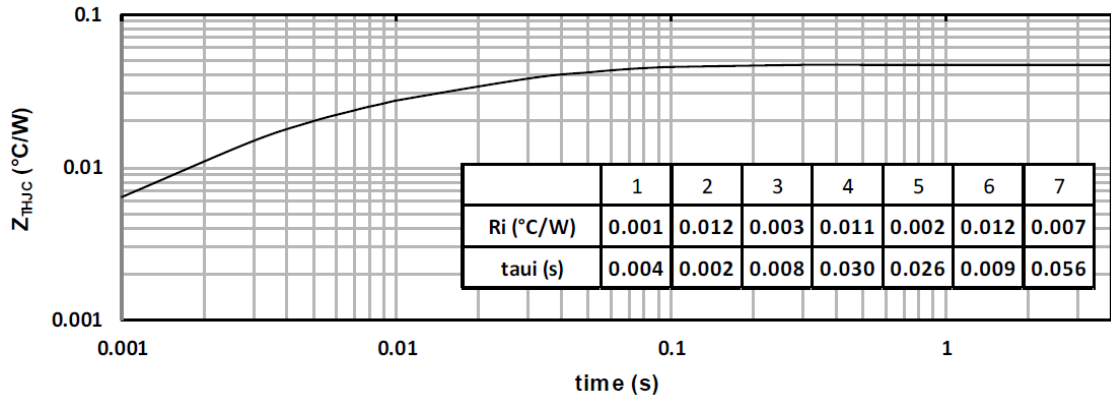
$$R_T = \frac{R_{25}}{\exp \left[ B_{25/85} \left( \frac{1}{T_{25}} - \frac{1}{T} \right) \right]}$$

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

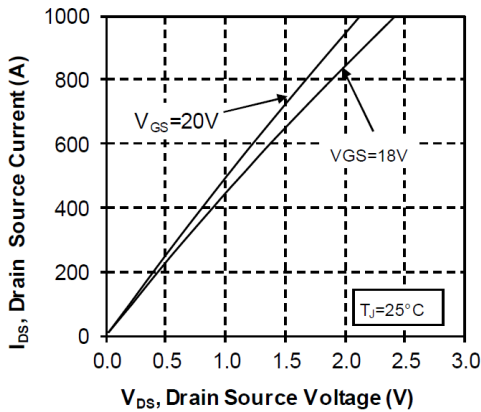
### 3.4 SiC MOSFET Performance Curves

The following images show the SiC MOSFET performance curves of the MSCSM120AM03CT6LIAG device.

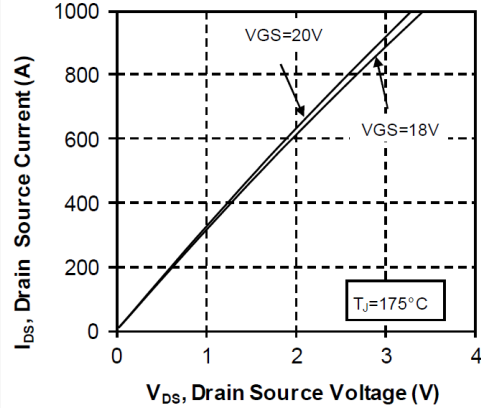
**Figure 3 • Maximum Thermal Impedance**



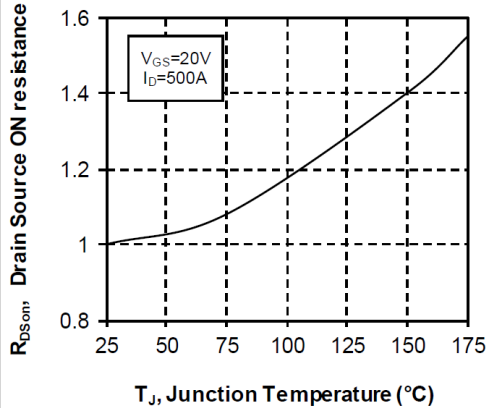
**Figure 4 • Output Characteristics, T<sub>J</sub> = 25 °C**



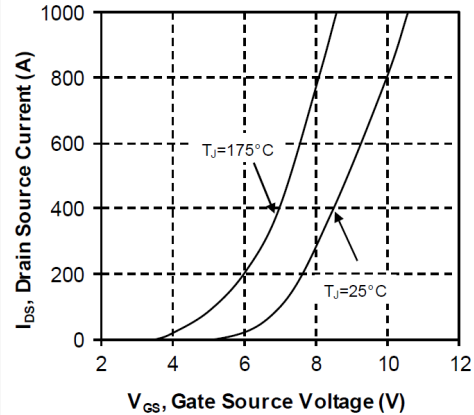
**Figure 5 • Output Characteristics, T<sub>J</sub> = 175 °C**



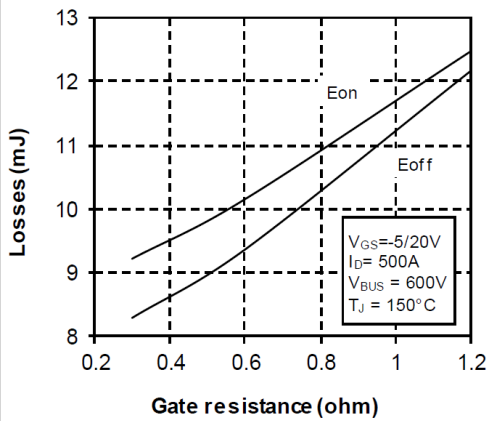
**Figure 6 • Normalized R<sub>DS(on)</sub> vs. Temperature**



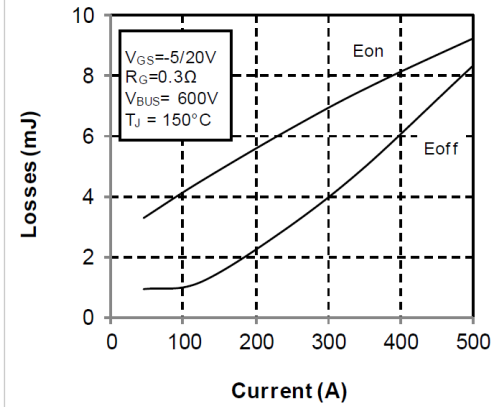
**Figure 7 • Transfer Characteristics**



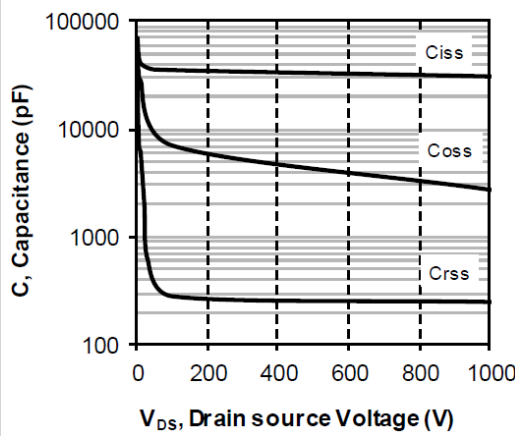
**Figure 8 • Switching Energy vs. Rg**



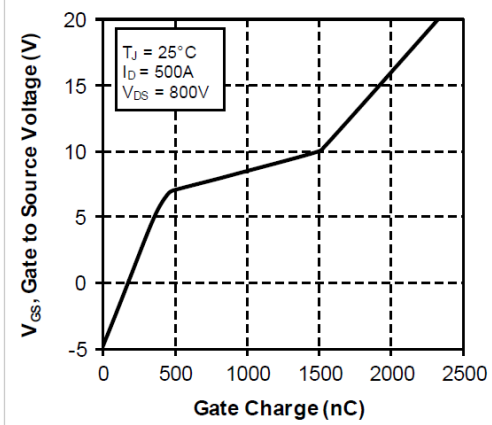
**Figure 9 • Switching Energy vs. Current**



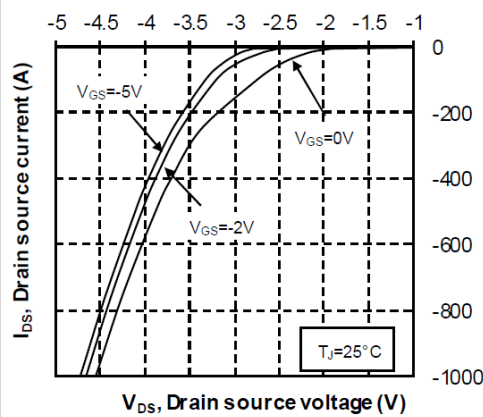
**Figure 10 • Capacitance vs. Drain Source Voltage**



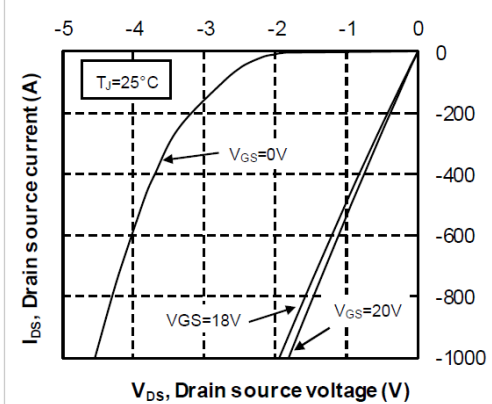
**Figure 11 • Gate Charge vs. Gate Source Voltage**



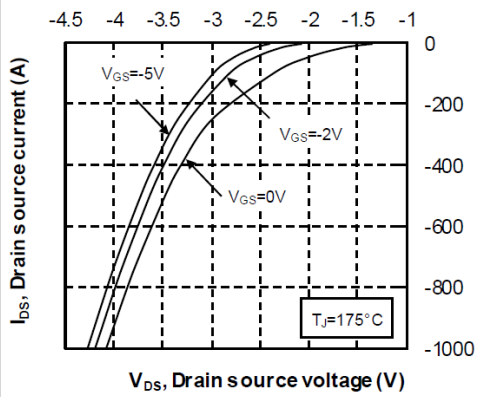
**Figure 12 • Body Diode Characteristics, TJ=25 °C**



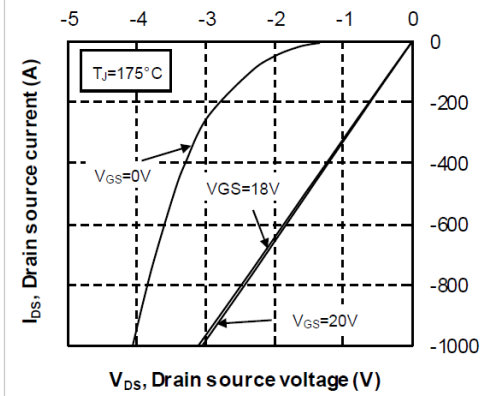
**Figure 13 • 3<sup>rd</sup> Quadrant Characteristics, TJ=25 °C**



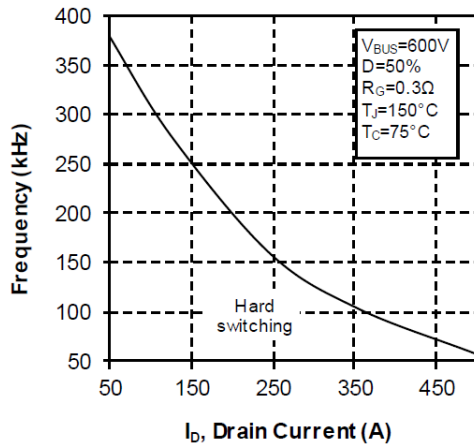
**Figure 14 • Body Diode Characteristics,  $T_J=175^\circ\text{C}$**



**Figure 15 • 3<sup>rd</sup> Quadrant Characteristics,  $T_J=175^\circ\text{C}$**



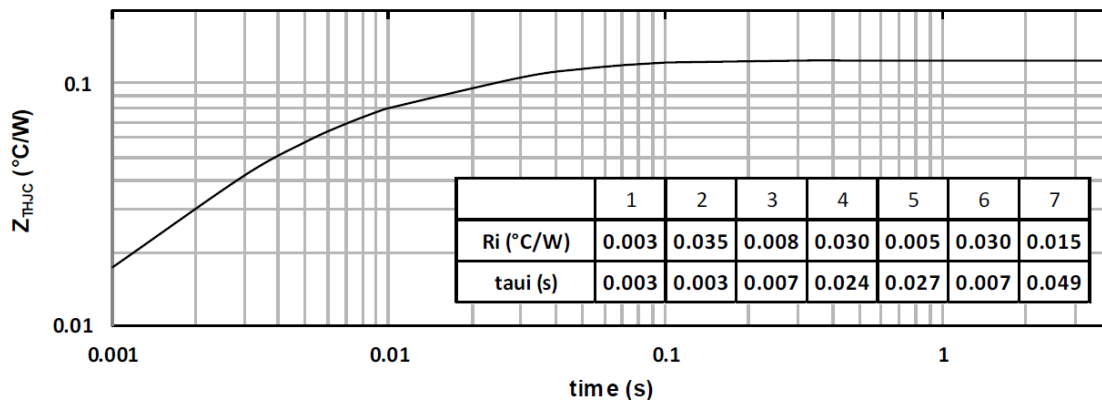
**Figure 16 • Operating Frequency vs. Drain Current**



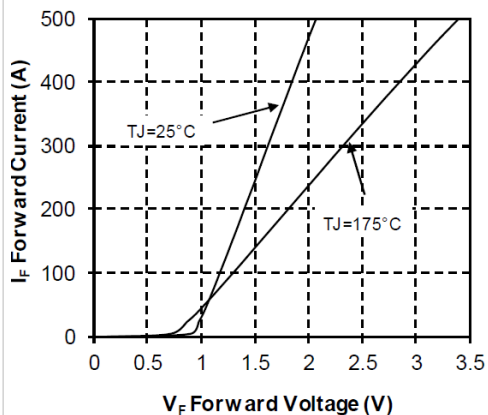
### 3.5 SiC Diode Performance Curves

The following images show the SiC diode performance curves of MSCSM120AM03CT6LIAG device.

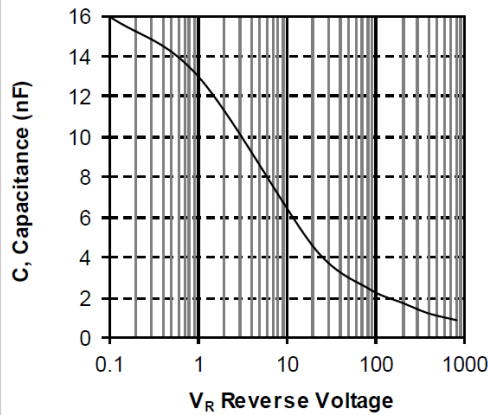
**Figure 17 • Maximum Thermal Impedance**



**Figure 18 • Forward Characteristics**



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



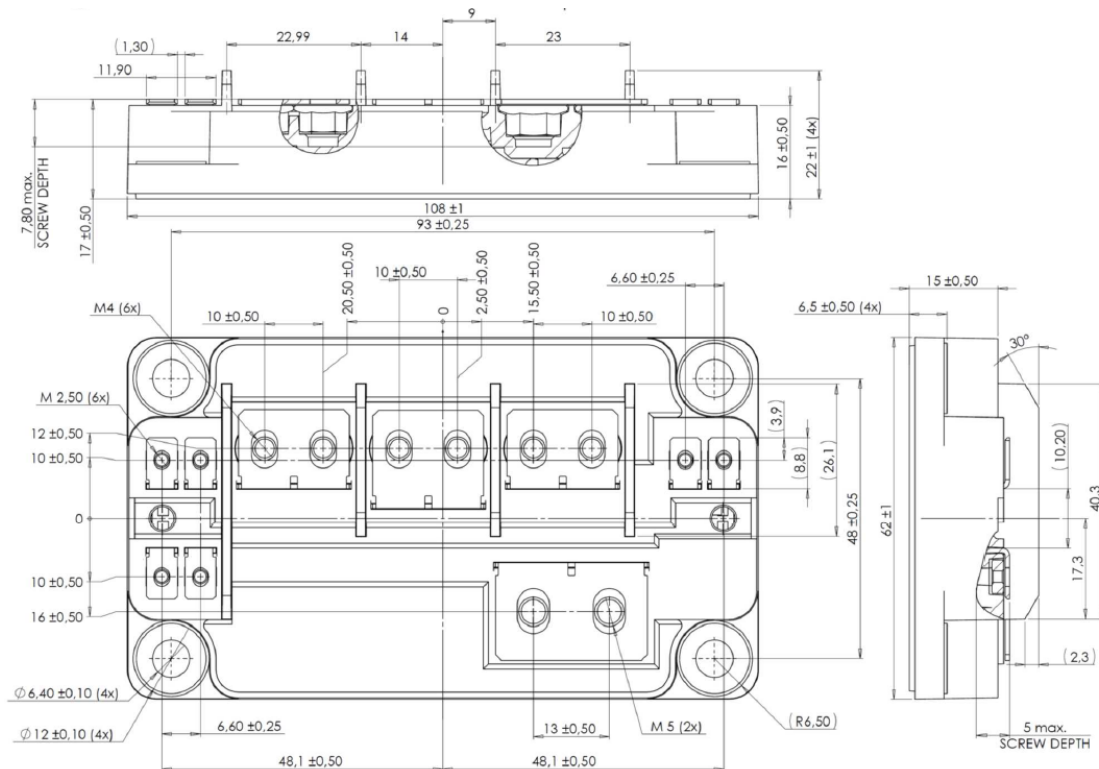
## 4 Package Specification

The following section shows the package specification of MSCSM120AM03CT6LIAG device.

### 4.1 Package Outline Drawing

The following image illustrates the package outline drawing of MSCSM120AM03CT6LIAG device. The dimensions are in millimeters.

Figure 20 • Package Outline Drawing



**Note:**

See [AN1911—Mounting instructions for SP6 Low inductance Power Module](#) application note.

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[T512F-YEB](#) [T513F](#) [T514F](#) [T554](#) [T612FSE](#) [25.161.3453.0](#) [25.179.2253.0](#) [25.194.3253.0](#) [25.325.1253.1](#) [25.326.4253.1](#) [25.330.0953.1](#)  
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