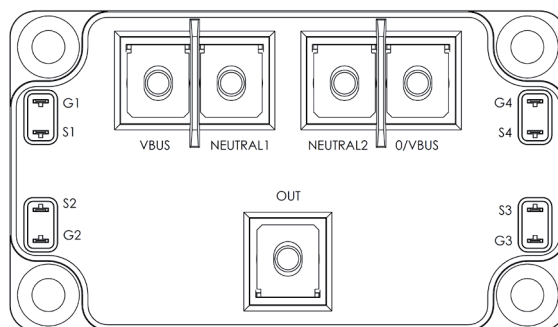
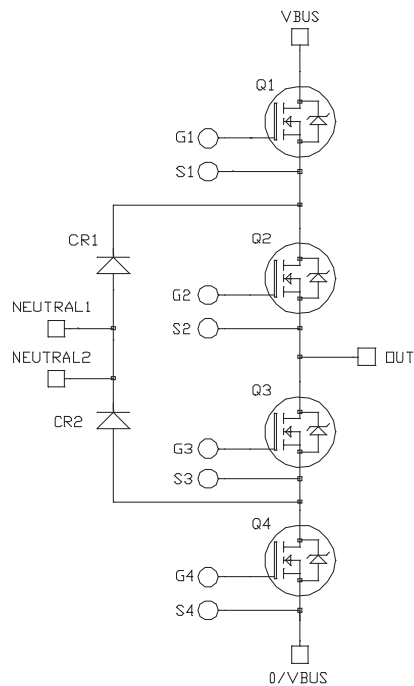


## Three Level Inverter SiC MOSFET Power Module

### Product Overview

The MSCSM120TLM08CAG device is a three level inverter 1200V/333A silicon carbide (SiC) MOSFET power module.



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



These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

## Features

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The following are key features of the MSCSM120TLM08CAG 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  $V_F$
- Low stray inductance
- Kelvin source for easy drive
- M5 power connectors
- High level of integration
- Aluminum nitride (AlN) substrate for improved thermal performance

## Benefits

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The following are the benefits of MSCSM120TLM08CAG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS Compliant

## Application

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The MSCSM120TLM08CAG device is designed for the following applications:

- Solar converter
- Uninterruptible power supplies

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120TLM08CAG device.

### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120TLM08CAG device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	333
		$T_C = 80\text{ }^\circ\text{C}$	265
$I_{DM}$	Pulsed drain current	660	
$V_{GS}$	Gate-Source voltage	-10/25	V
$R_{DS(on)}$	Drain-Source ON resistance	7.8	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	1378

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120TLM08CAG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$	—	40	400	$\mu\text{A}$	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 80A$	$T_J = 25\text{ }^\circ\text{C}$	—	6.3	7.8	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	10	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 4\text{ mA}$	1.8	2.8	—	V	
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20V$ $V_{DS} = 0V$	—	—	400	nA	

# MSCSM120TLM08CAG

## Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120TLM08CAG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0V$	—	12	—	nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000V$	—	1	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.1	—	
$Q_g$	Total gate charge	$V_{GS} = -5V/20V$	—	928	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 800V$	—	164	—	
$Q_{gd}$	Gate-drain charge	$I_D = 160A$	—	200	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	—	60	—	ns
$T_r$	Rise time	$V_{Bus} = 600V$				
$T_{d(off)}$	Turn-off delay time	$I_D = 200A$				
$T_f$	Fall time	$R_{G(on)} = 2\Omega$ $R_{G(off)} = 1.2\Omega$				
$E_{on}$	Turn-on energy	$V_{GS} = -5V/20V$	—	4.1	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 600V$ $I_D = 200A$ $R_{G(on)} = 2\Omega$ $R_{G(off)} = 1.2\Omega$				
$R_{Gint}$	Internal gate resistance		—	1.5	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.11	$^{\circ}C/W$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120TLM08CAG device.

**Table 1-4. Body Diode Ratings and Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0V$ $I_{SD} = 160A$	—	4	—	V
		$V_{GS} = -5V$ $I_{SD} = 160A$	—	4.2	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 160A$	—	90	—	ns
$Q_{rr}$	Reverse recovery charge	$V_{GS} = -5V$	—	2200	—	nC
$I_{rr}$	Reverse recovery current	$V_R = 800V$ $di_F/dt = 4000A/\mu s$	—	54	—	A

### 1.2 CR1 and CR2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the CR1 and CR2 SiC diode ratings and characteristics per SiC diode of MSCSM120TLM08CAG device.

**Table 1-5. SiC Schottky Diode Ratings and Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
$V_{RRM}$	Peak repetitive reverse voltage		—	—	1200	V	
$I_{RRM}$	Reverse leakage current	$V_R = 1200V$	$T_J = 25\text{ }^\circ\text{C}$	—	60	600	$\mu\text{A}$
			$T_J = 175\text{ }^\circ\text{C}$	—	1000	—	
$I_F$	DC forward current		$T_C = 100\text{ }^\circ\text{C}$	—	200	—	A
$V_F$	Diode forward voltage	$I_F = 200A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600V$	—	896	—	nC	
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400V$	—	984	—	$\mu\text{F}$	
		$f = 1\text{ MHz}, V_R = 800V$	—	728	—		
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.16	$^\circ\text{C/W}$	

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120TLM08CAG device.

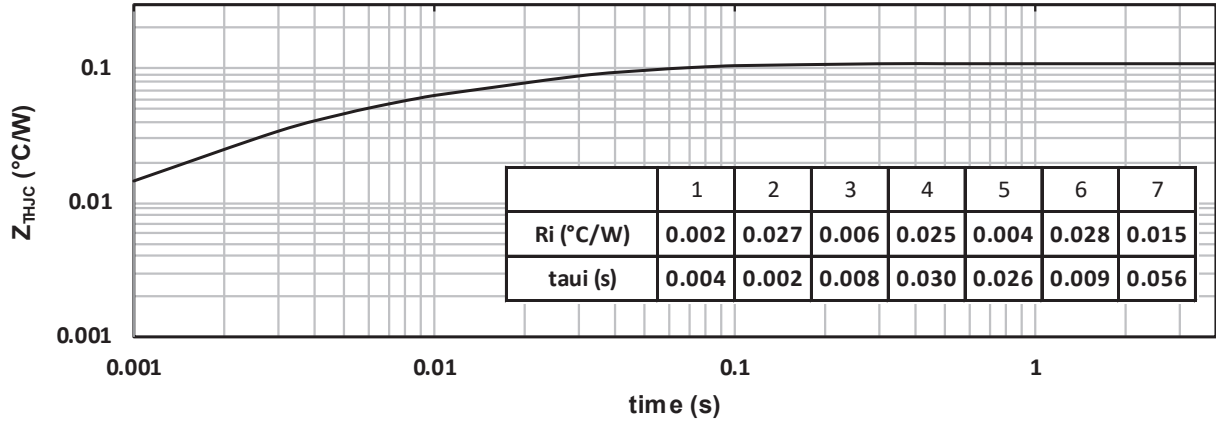
**Table 1-6. Thermal and Package Characteristics**

Symbol	Characteristics	Min.	Max.	Unit		
$V_{ISOL}$	RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50 Hz/60 Hz	4000	—	V		
$T_J$	Operating junction temperature range	-40	175	$^\circ\text{C}$		
$T_{JOP}$	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	To heatsink	M6		3	5
		For terminals	M5	2	3.5	
Wt	Package weight	—	300	g		

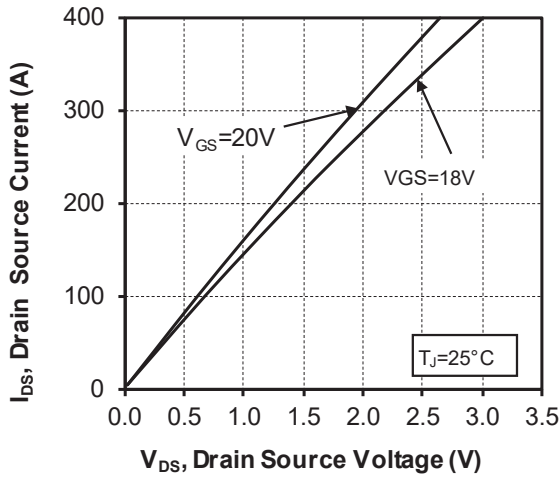
### 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120TLM08CAG device.

**Figure 1-1. Maximum Thermal Impedance**



**Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$**



**Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$**

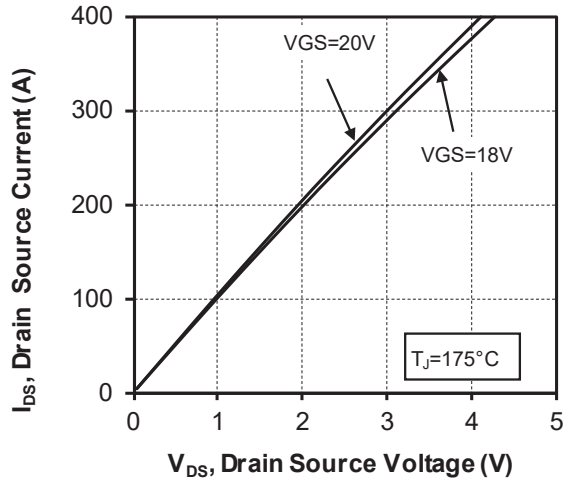


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

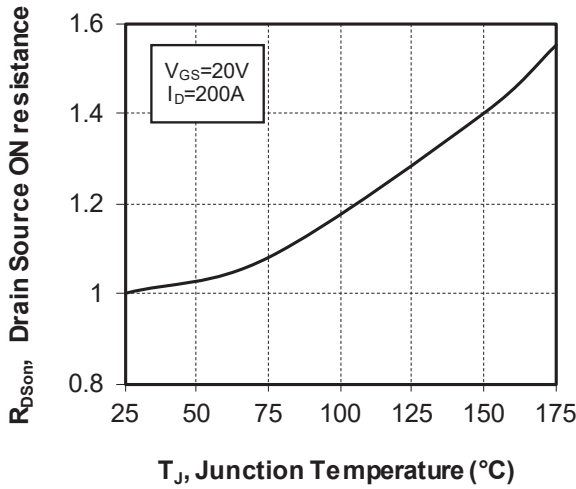


Figure 1-5. Transfer Characteristics

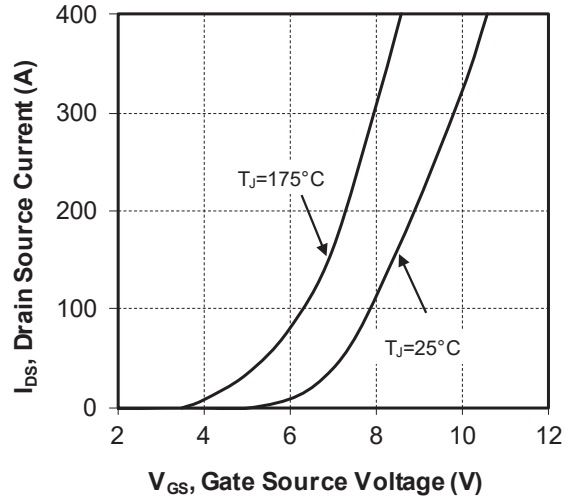


Figure 1-6. Switching Energy vs.  $R_g$

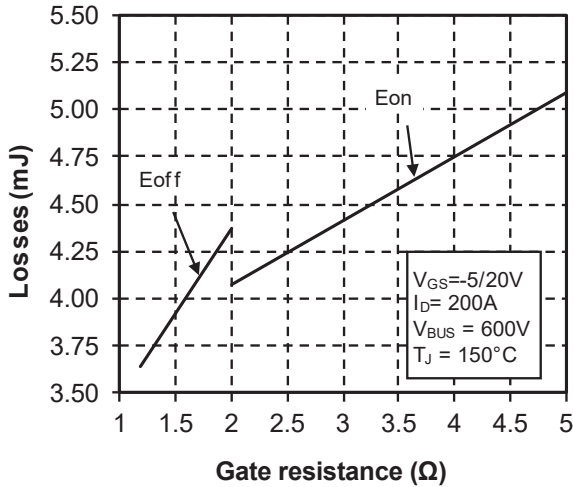


Figure 1-7. Switching Energy vs. Current

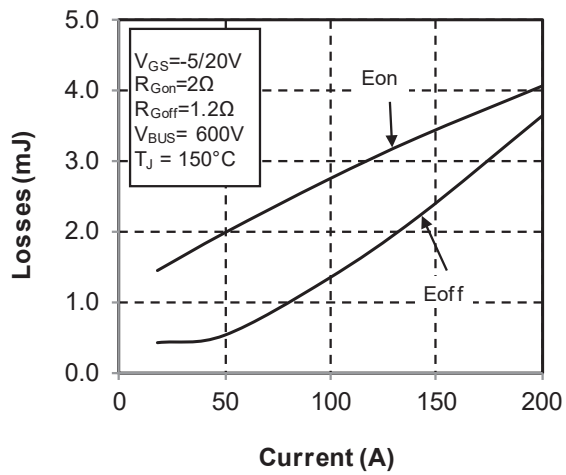


Figure 1-8. Capacitance vs. Drain Source Voltage

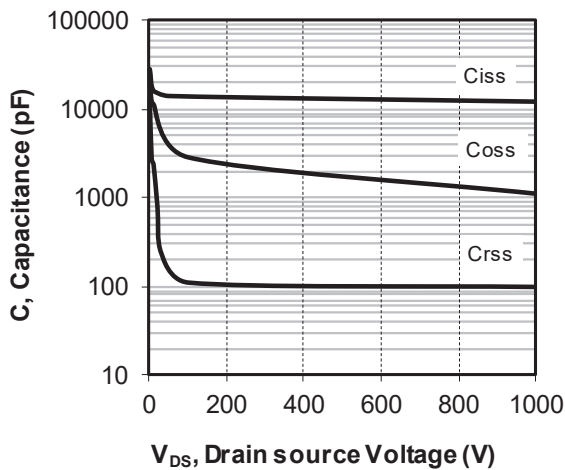


Figure 1-9. Gate Charge vs. Gate Source Voltage

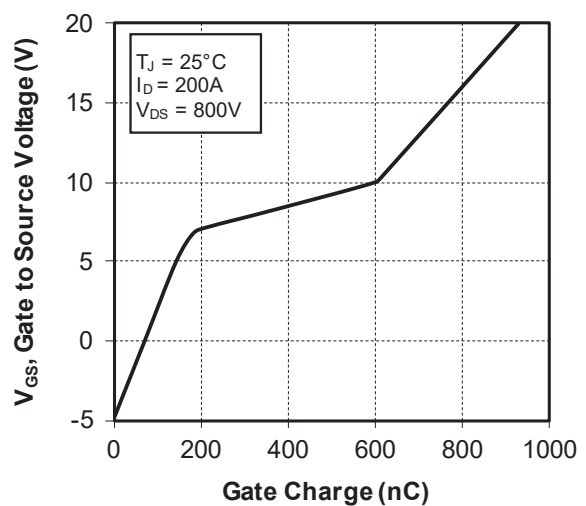


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

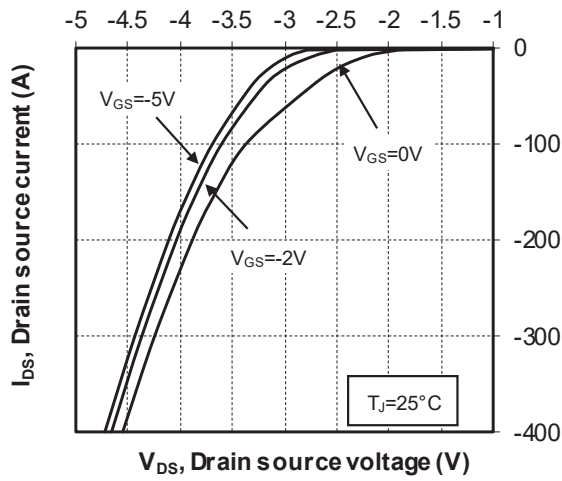


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

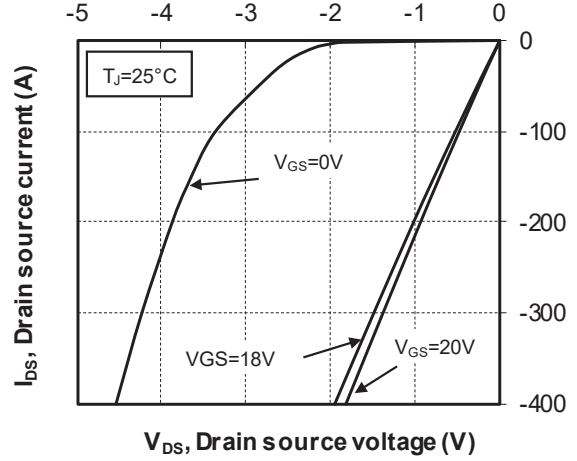


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

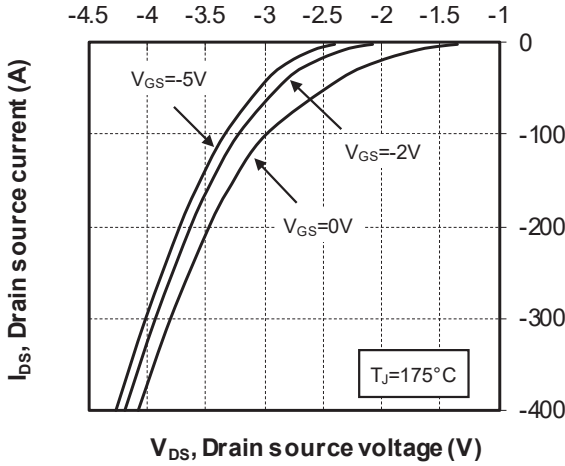


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

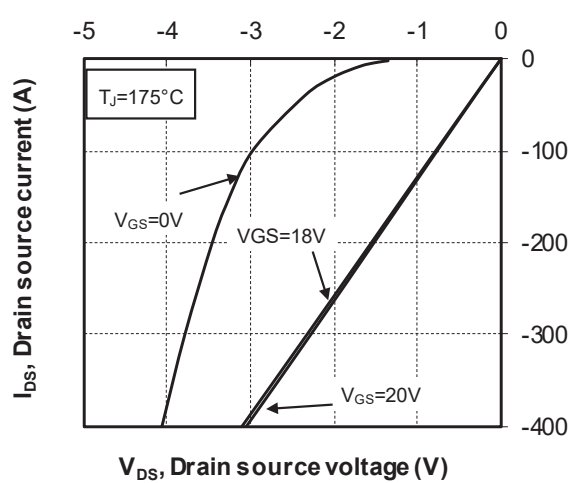
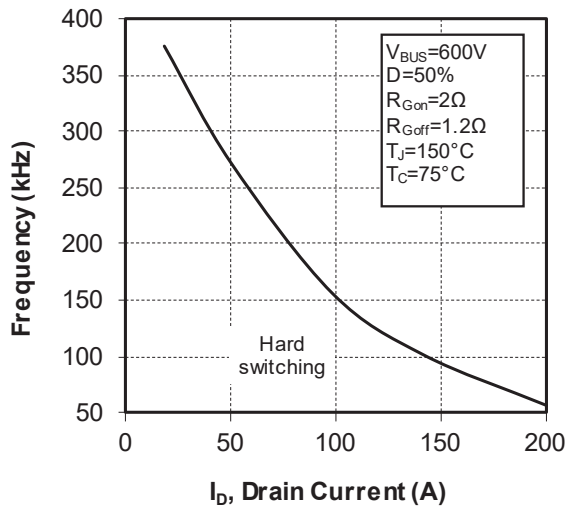


Figure 1-14. Operating Frequency vs Drain Current

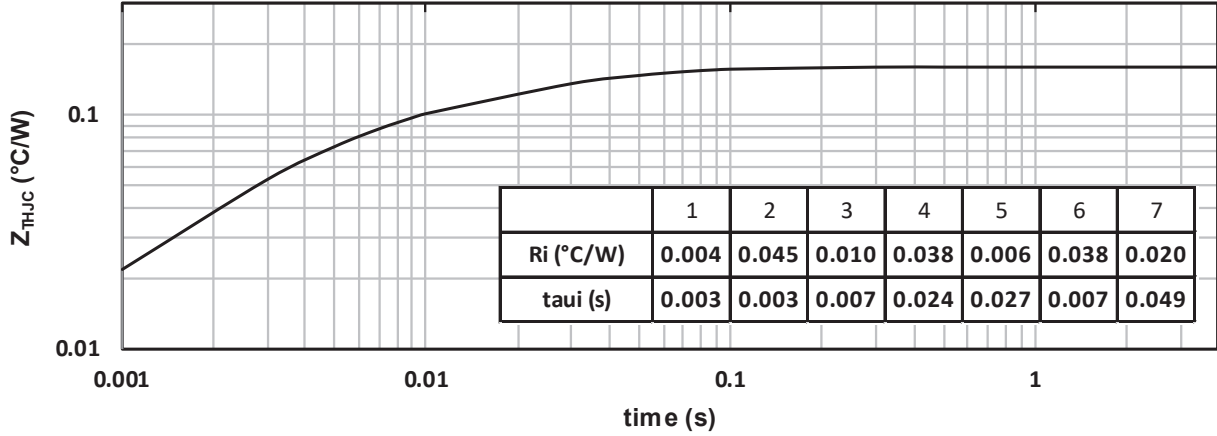




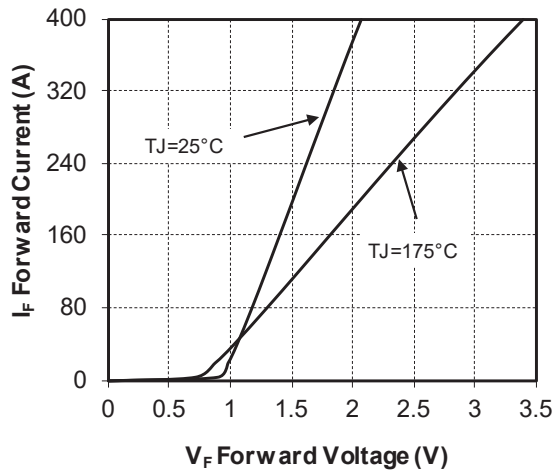
**1.5 Typical SiC Diode Performance Curves**

This section shows the typical SiC diode performance curves of the MSCSM120TLM08CAG device.

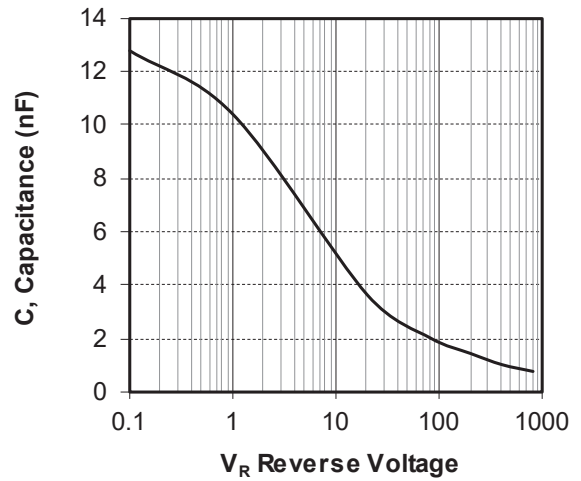
**Figure 1-15. Maximum Thermal Impedance**



**Figure 1-16. Forward Characteristics**



**Figure 1-17. Capacitance vs. Reverse Voltage**





**3. Revision History**

Revision	Date	Description
A	12/2021	This is the first publication of this document.

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