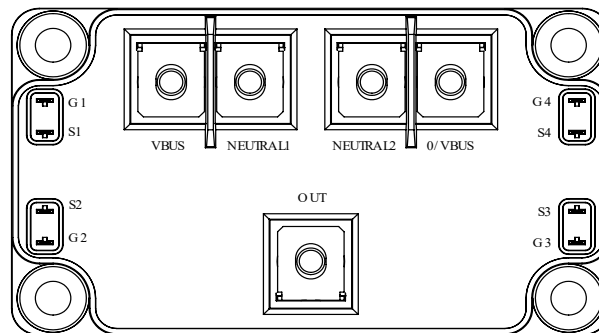
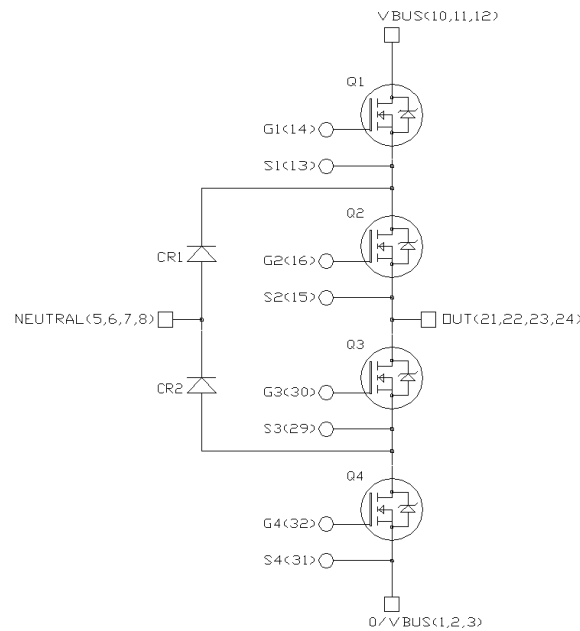


## Three Level Inverter SiC MOSFET Power Module

### Product Overview

The MSCSM170TLM11CAG device is a three level inverter 1700V/189A silicon carbide (SiC) MOSFET power module.



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



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

## Features

The following are key features of the MSCSM170TLM11CAG 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
- Low stray inductance
- Kelvin source for easy drive
- High level of integration
- Aluminum nitride (AlN) substrate for improved thermal performance
- M5 power connectors

## Benefits

The following are the benefits of MSCSM170TLM11CAG device:

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

## Application

The MSCSM170TLM11CAG device is designed for the following applications:

- Uninterruptible power supplies
- Solar converter

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM170TLM11CAG device.

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

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170TLM11CAG device.

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

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	238
		$T_C = 80\text{ }^\circ\text{C}$	189
$I_{DM}$	Pulsed drain current	480	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	11.3	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	1114

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170TLM11CAG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}; V_{DS} = 1700\text{ V}$	—	40	400	$\mu\text{A}$	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 120\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	8.8	11.3	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	15.4	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}; I_D = 10\text{ mA}$	1.8	3.2	—	V	
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{ V}; V_{DS} = 0\text{ V}$	—	—	400	nA	

# MSCSM170TLM11CAG

## Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170TLM11CAG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	—	13200	—	pF
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$	—	600	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	40	—	
$Q_g$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	712	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 850\text{V}$	—	196	—	
$Q_{gd}$	Gate-drain charge	$I_D = 120\text{A}$	—	108	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5\text{V}/20\text{V}$	—	75	—	ns
$T_r$	Rise time	$V_{Bus} = 900\text{V}$				
$T_{d(off)}$	Turn-off delay time	$I_D = 200\text{A}$				
$T_f$	Fall time	$R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$				
$E_{on}$	Turn-on energy	$V_{GS} = -5\text{ V}/20\text{V}$	—	9	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 900\text{V}$ $I_D = 200\text{A}$ $R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$	—	4.8	—	
$R_{Gint}$	Internal gate resistance		—	1.46	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.135	$^{\circ}\text{C}/\text{W}$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170TLM11CAG device.

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

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{V}; I_{SD} = 120\text{A}$	—	3.7	—	V
		$V_{GS} = -5\text{V}; I_{SD} = 120\text{A}$	—	3.9	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 120\text{A}; V_{GS} = -5\text{V}$	—	27	—	ns
$Q_{rr}$	Reverse recovery charge	$V_R = 900\text{V}; di_F/dt = 4000\text{ A}/\mu\text{s}$	—	2600	—	nC
$I_{rr}$	Reverse recovery current		—	184	—	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 MSCSM170TLM11CAG device.

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

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
$V_{RRM}$	Peak repetitive reverse voltage			—	—	1700	V
$I_{RRM}$	Reverse leakage current	$V_R = 1700V$	$T_J = 25\text{ }^\circ\text{C}$	—	40	800	$\mu\text{A}$
			$T_J = 175\text{ }^\circ\text{C}$	—	600	—	
$I_F$	DC forward current	—	$T_C = 125\text{ }^\circ\text{C}$	—	120	—	A
$V_F$	Diode forward voltage	$I_F = 120A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.3	—	
$Q_C$	Total capacitive charge	$V_R = 900V$		—	920	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600V$		—	668	—	$\text{pF}$
		$f = 1\text{ MHz}, V_R = 900V$		—	552	—	
$R_{thJC}$	Junction-to-case thermal resistance			—	—	0.149	$^\circ\text{C/W}$

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170TLM11CAG device.

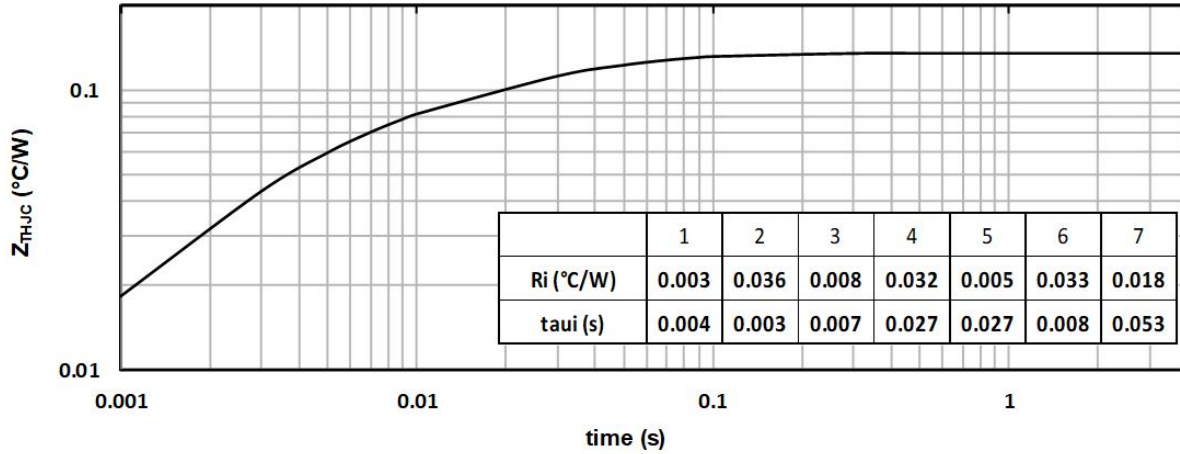
**Table 1-6. Thermal and Package Characteristics**

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	M4	3		5
		For terminals	M5	2	3.5	
Wt	Package weight		—	300	g	

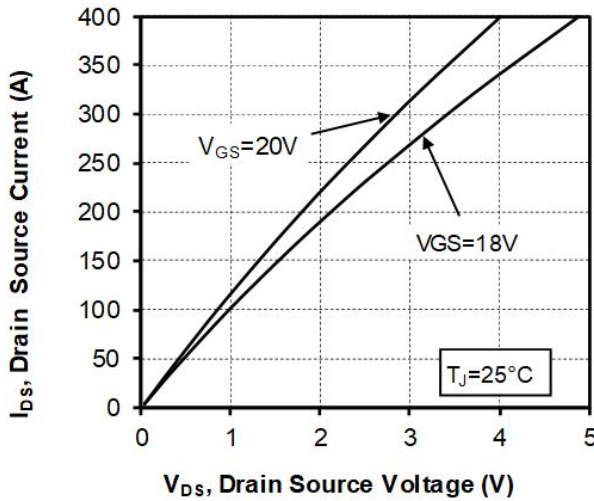
### 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM170TLM11CAG device.

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



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



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

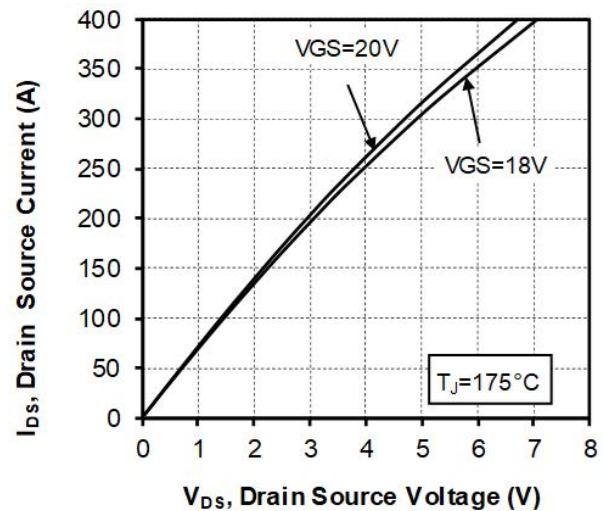


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

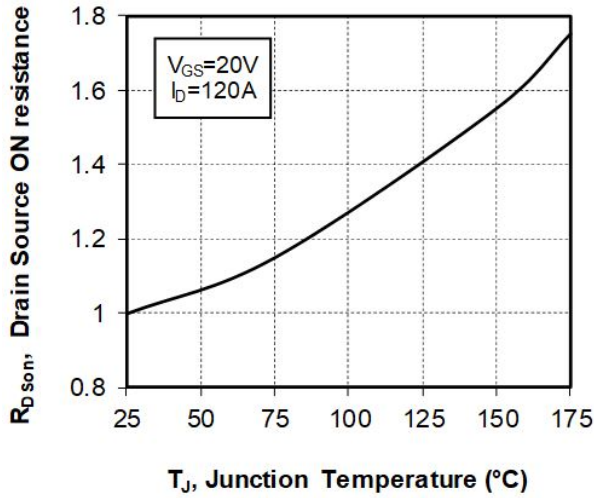


Figure 1-5. Transfer Characteristics

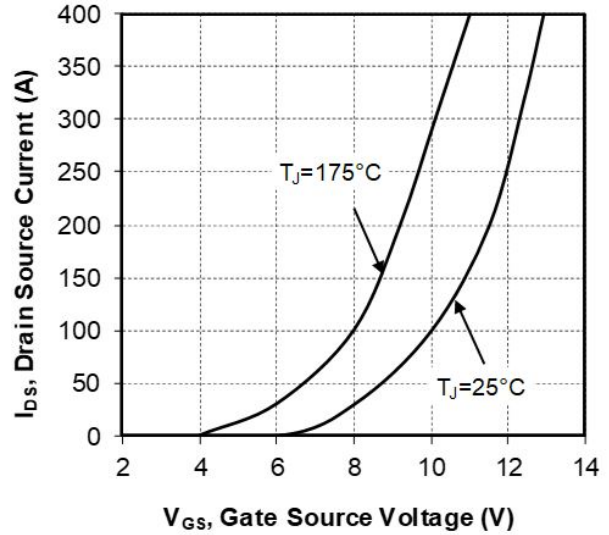


Figure 1-6. Switching Energy vs.  $R_g$

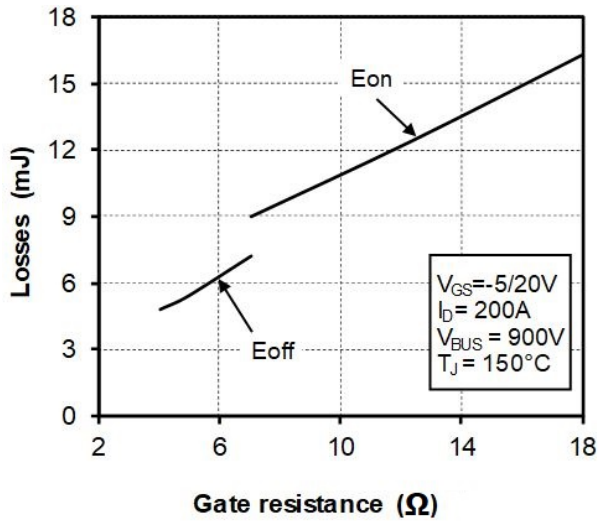


Figure 1-7. Switching Energy vs. Current

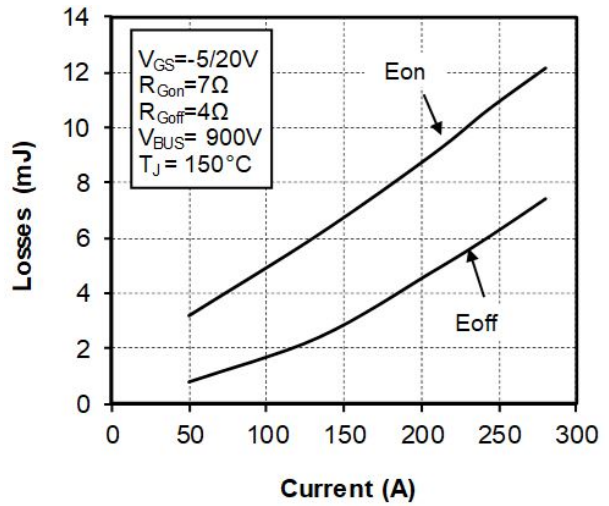


Figure 1-8. Capacitance vs. Drain Source Voltage

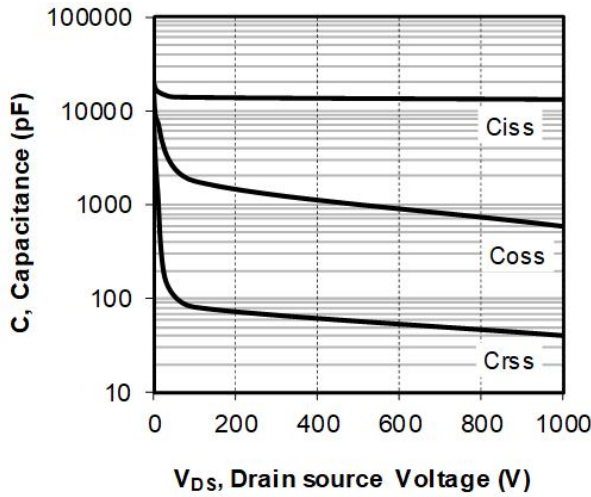


Figure 1-9. Gate Charge vs. Gate Source Voltage

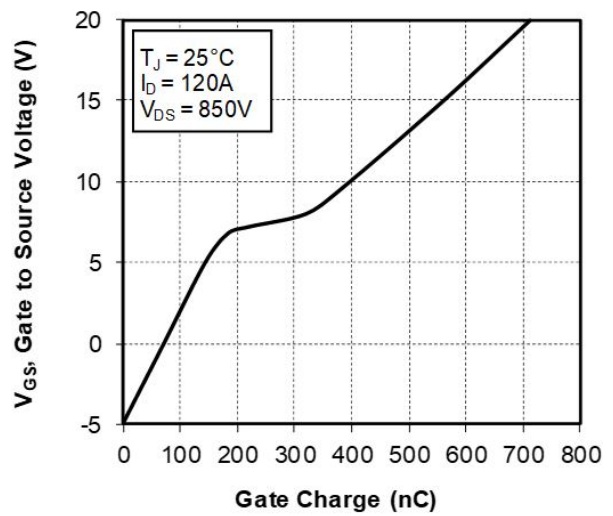


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

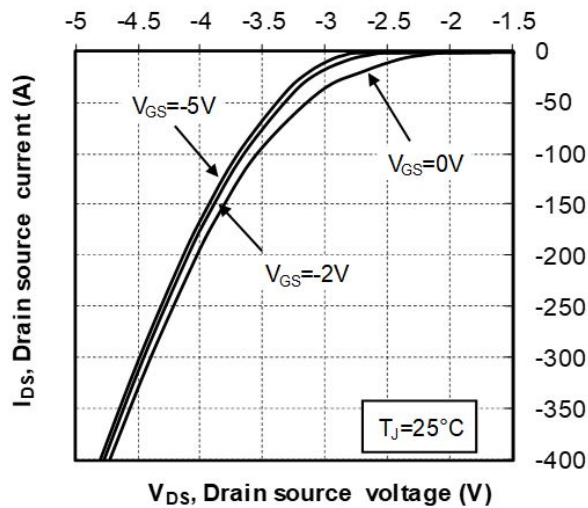


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

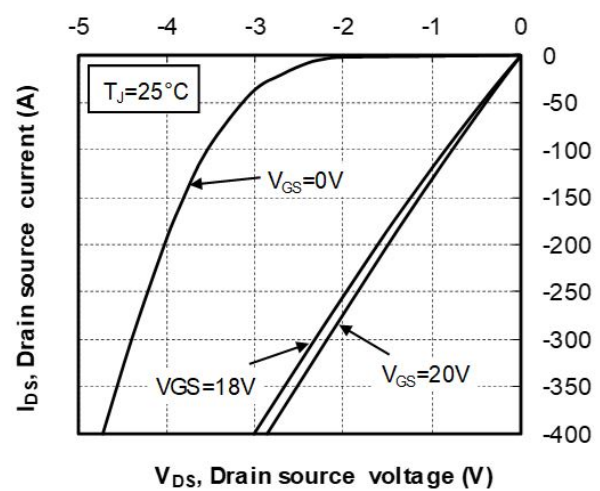


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

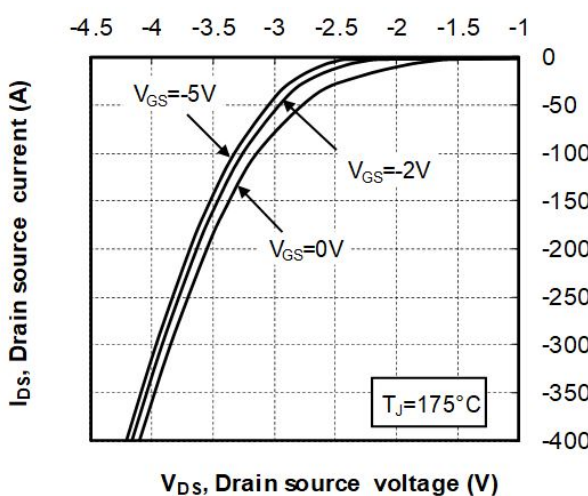


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

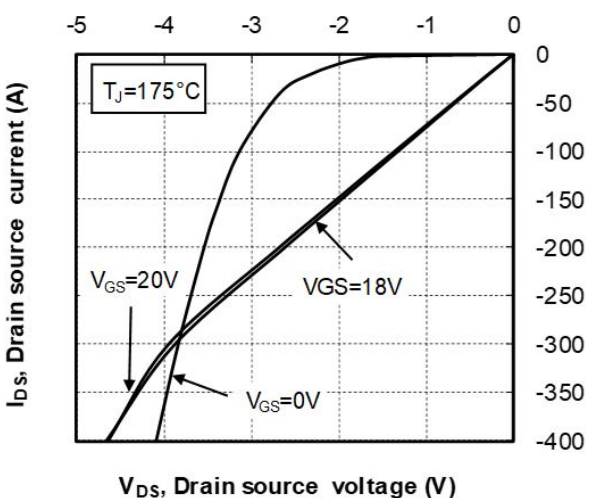
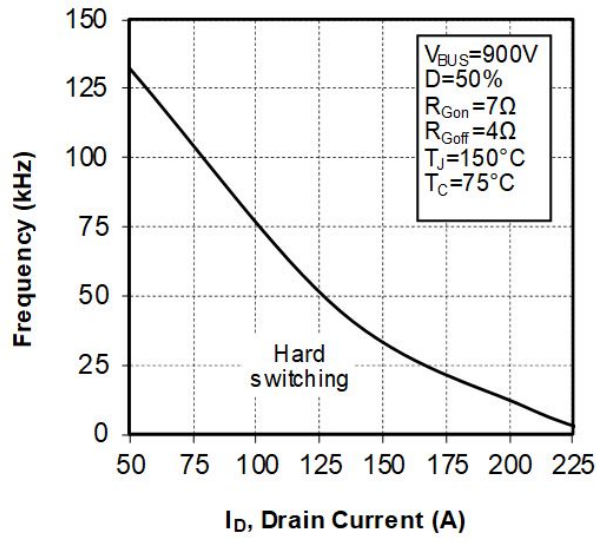




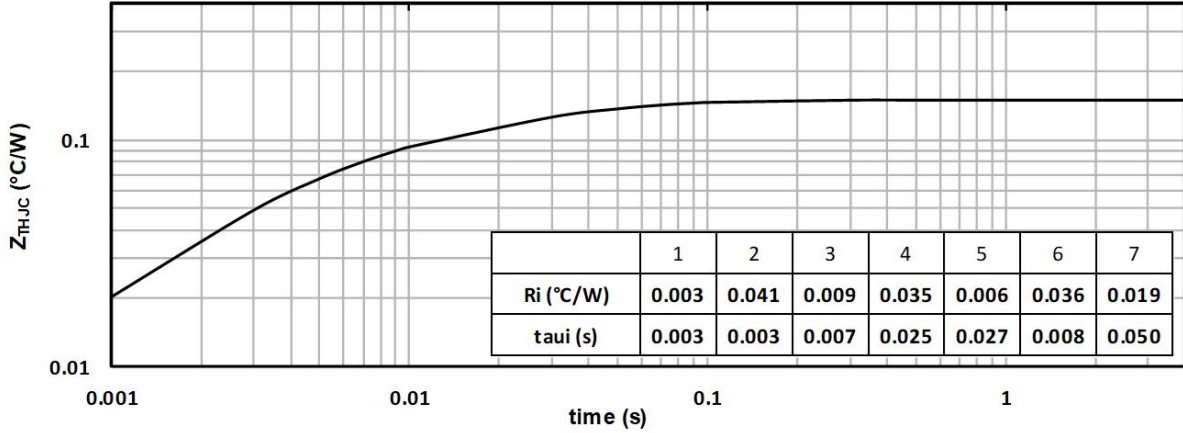
Figure 1-14. Operating Frequency vs Drain Current



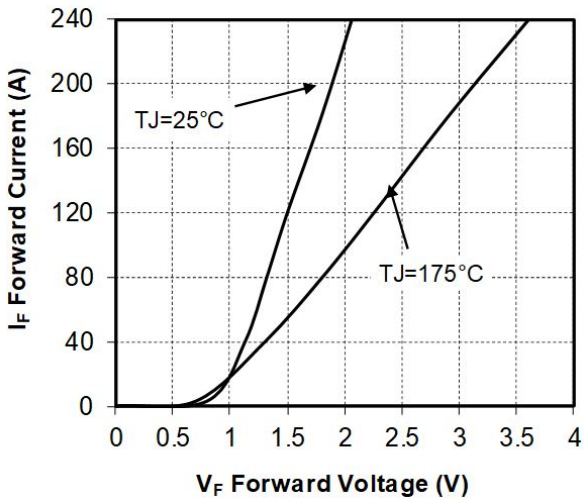
**1.5 Typical SiC Diode Performance Curves**

This section shows the typical SiC diode performance curves of the MSCSM170TLM11CAG device.

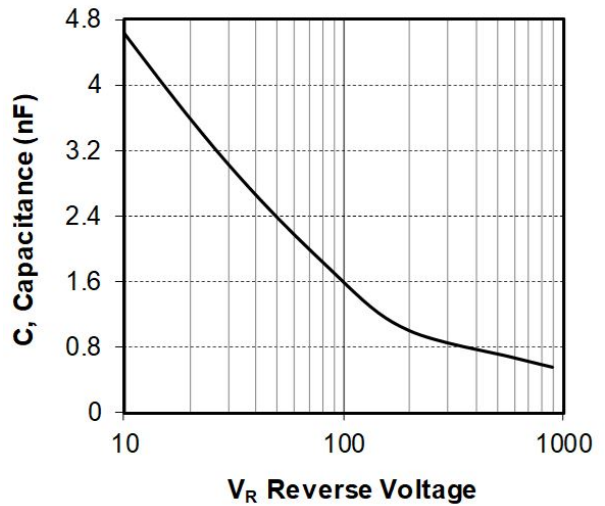
**Figure 1-15. Maximum Thermal Impedance**



**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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