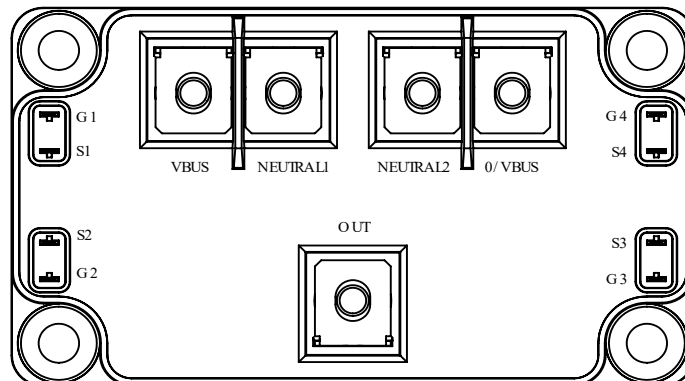
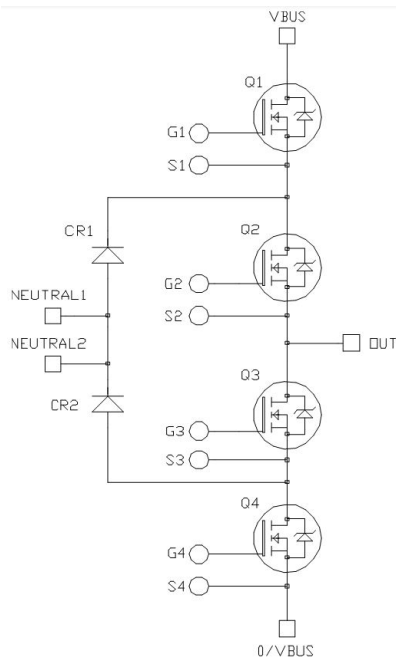


## Three Level Inverter SiC MOSFET Power Module

### Product Overview

The MSCSM120TLM11CAG device is a three level inverter 1200V/251A 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

The following are key features of the MSCSM120TLM11CAG 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
- M5 power connectors
- High level of integration
- Aluminum nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM120TLM11CAG 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 MSCSM120TLM11CAG device is designed for the following applications:

- Solar converter
- Uninterruptible power supplies

## Electrical Specifications

This section provides the electrical specifications of the MSCSM120TLM11CAG device.

### SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120TLM11CAG device.

**Table 1. Absolute Maximum Ratings**

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	251
		$T_C = 80\text{ }^\circ\text{C}$	200
$I_{DM}$	Pulsed drain current	500	
$V_{GS}$	Gate-Source voltage	-10/25	V
$R_{DS(on)}$	Drain-Source ON resistance	10.4	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	1042

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120TLM11CAG device.

**Table 2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0V$ ; $V_{DS} = 1200V$	—	30	300	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 120A$	$T_J = 25\text{ }^\circ\text{C}$	—	8.3	10.4
			$T_J = 175\text{ }^\circ\text{C}$	—	13.3	—
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ ; $I_D = 3\text{ mA}$	1.8	2.8	—	V
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20V$ ; $V_{DS} = 0V$	—	—	300	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120TLM11CAG device.

**Table 3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0V$	—	9	—	nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000V$	—	0.81	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.07	—	
$Q_g$	Total gate charge	$V_{GS} = -5V/20V$	—	696	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 800V$	—	123	—	
$Q_{gd}$	Gate-drain charge	$I_D = 120A$	—	150	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	—	56	—	ns
$T_r$	Rise time	$V_{Bus} = 600V$				
$T_{d(off)}$	Turn-off delay time	$I_D = 150A$				
$T_f$	Fall time	$R_{G(on)} = 2.7\Omega$ $R_{G(off)} = 1.6\Omega$				
$E_{on}$	Turn-on energy	$V_{GS} = -5V/20V$	—	3	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 600V$ $I_D = 150A$ $R_{G(on)} = 2.7\Omega$ $R_{G(off)} = 1.6\Omega$	—	2.7	—	
$R_{Gint}$	Internal gate resistance		—	2	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.144	$^{\circ}C/W$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120TLM11CAG device.

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

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0V; I_{SD} = 120A$	—	4	—	V
		$V_{GS} = -5V; I_{SD} = 120A$	—	4.2	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 120A; V_{GS} = -5V$	—	90	—	ns
$Q_{rr}$	Reverse recovery charge	$V_R = 800V; di_F/dt = 3000\text{ A}/\mu\text{s}$	—	1650	—	nC
$I_{rr}$	Reverse recovery current		—	41	—	A

## 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 MSCSM120TLM11CAG device.

**Table 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	$V_R = 1200V$	$T_J = 25\text{ }^\circ\text{C}$	—	45	600	$\mu\text{A}$
			$T_J = 175\text{ }^\circ\text{C}$	—	750	—	
$I_F$	DC forward current	—	$T_C = 100\text{ }^\circ\text{C}$	—	150	—	A
$V_F$	Diode forward voltage	$I_F = 150A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600V$		—	672	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400V$		—	738	—	$\text{pF}$
		$f = 1\text{ MHz}, V_R = 800V$		—	546	—	
$R_{thJC}$	Junction-to-case thermal resistance			—	—	0.212	$^\circ\text{C/W}$

## Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120TLM11CAG device.

**Table 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	

## Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120TLM11CAG device.

Figure 1. Maximum Thermal Impedance

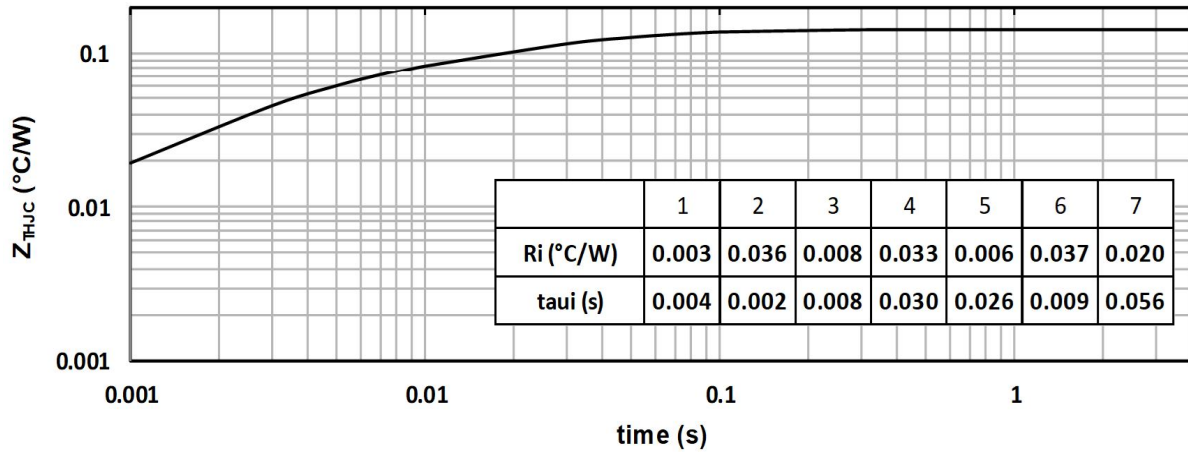


Figure 2. Output Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

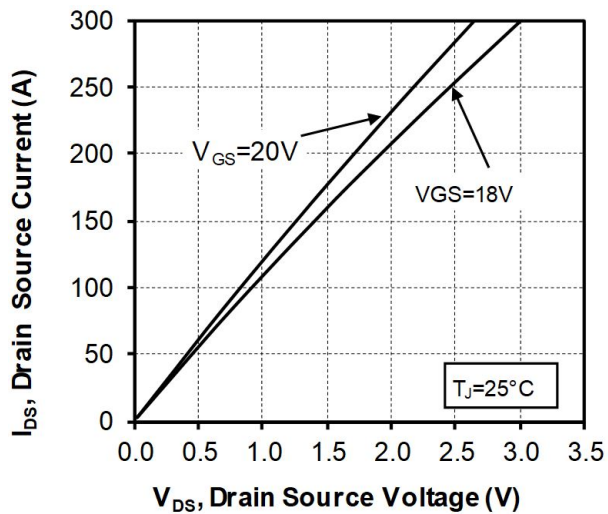


Figure 3. Output Characteristics,  $T_J = 175\text{ }^\circ\text{C}$

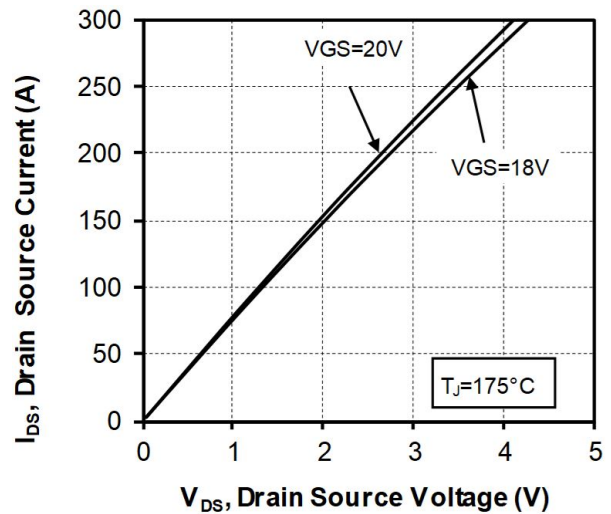


Figure 4. Normalized  $R_{DS(on)}$  vs. Temperature

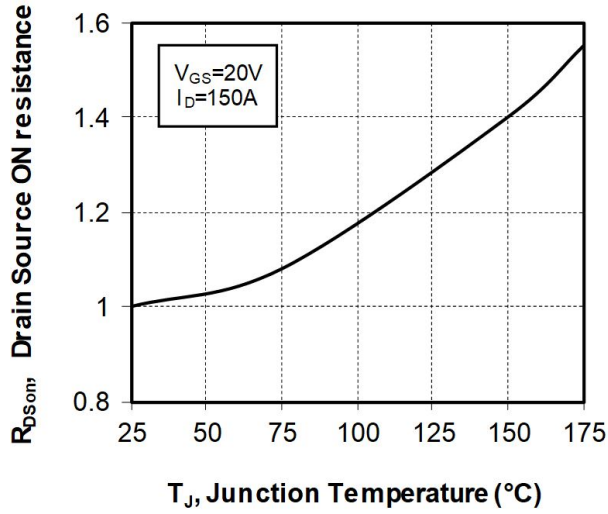


Figure 5. Transfer Characteristics

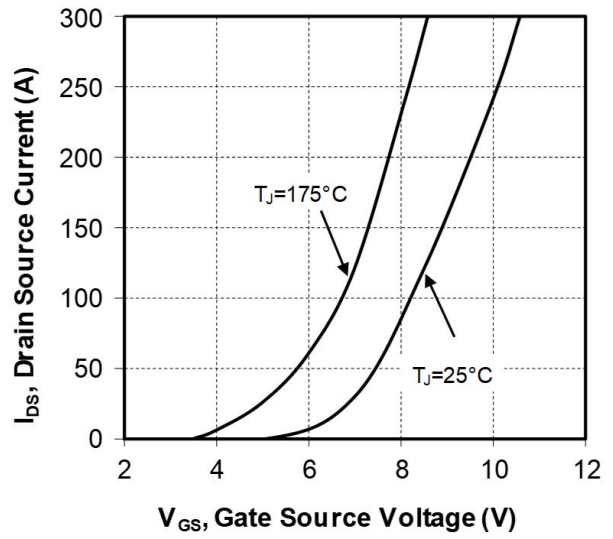


Figure 6. Switching Energy vs. Rg

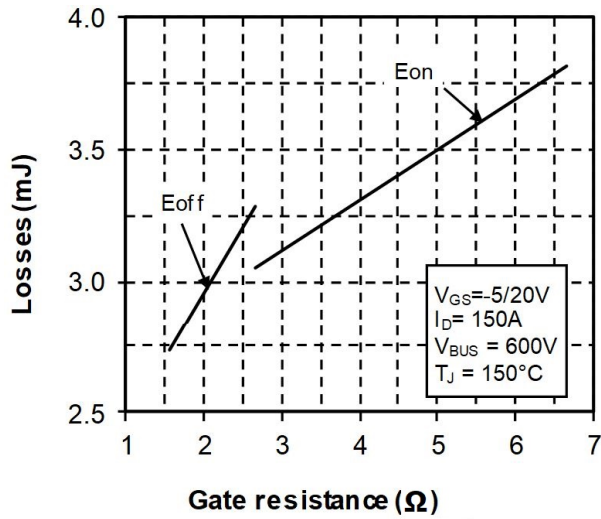


Figure 7. Switching Energy vs. Current

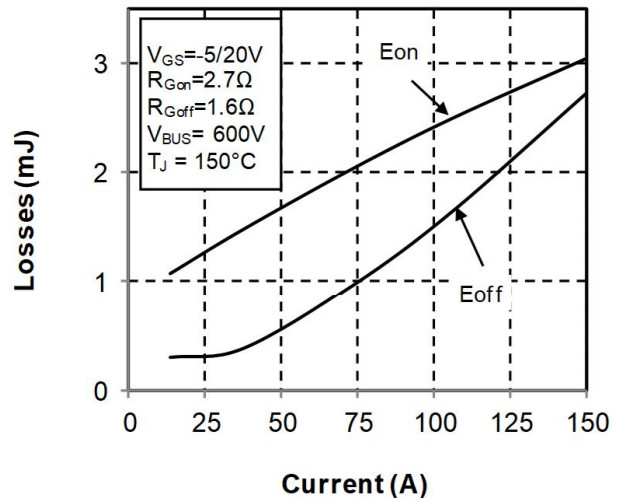


Figure 8. Capacitance vs. Drain Source Voltage

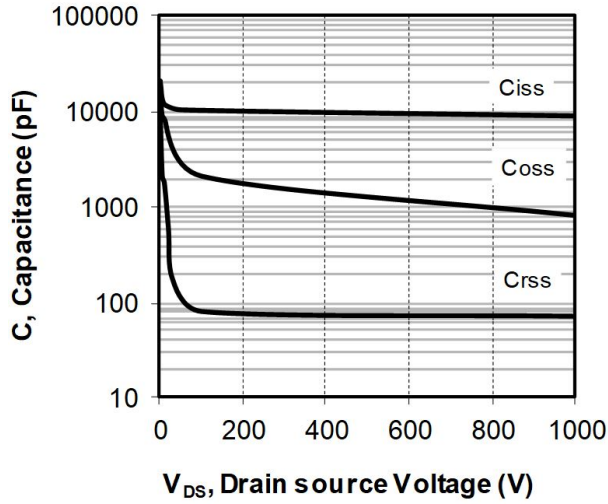


Figure 9. Gate Charge vs. Gate Source Voltage

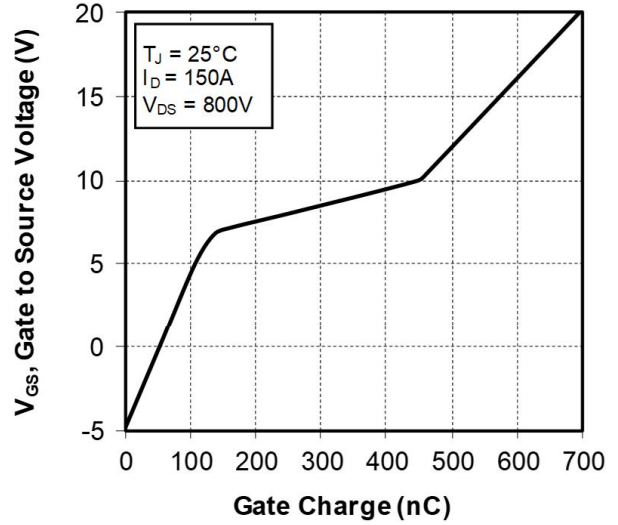


Figure 10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

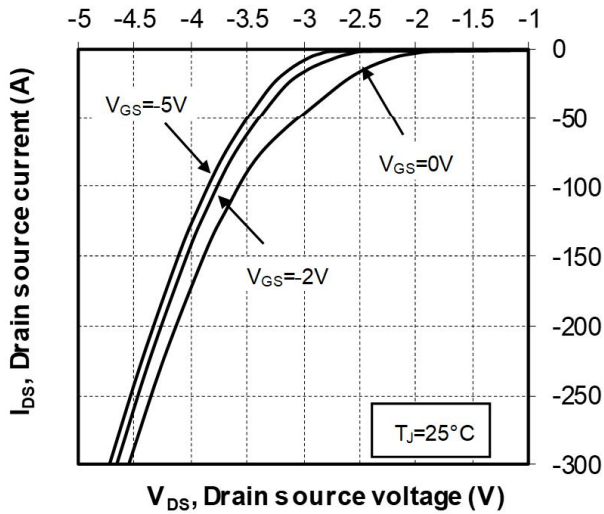


Figure 11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

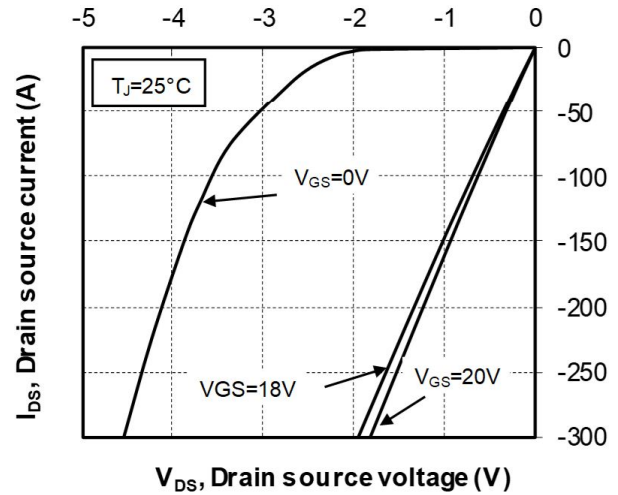




Figure 12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

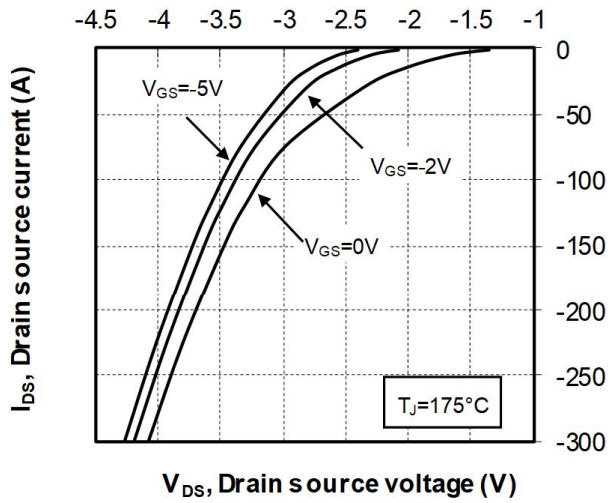


Figure 13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

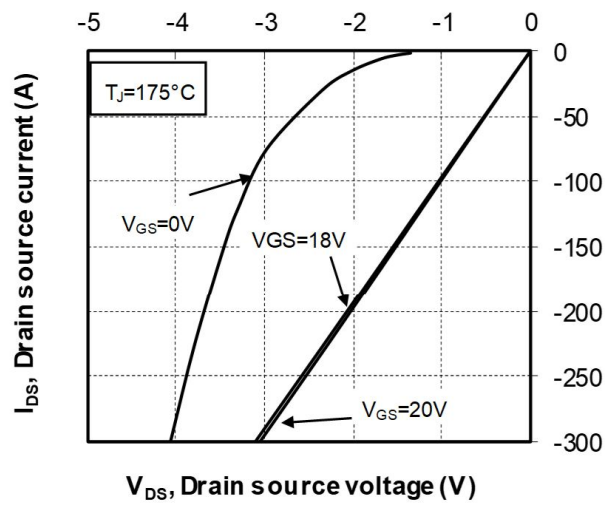
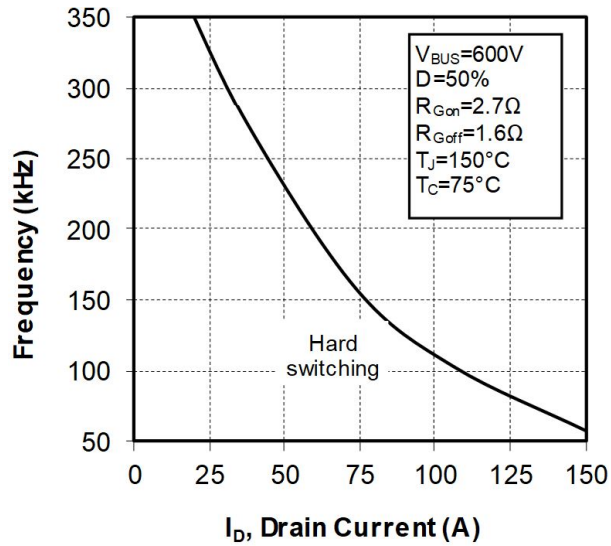


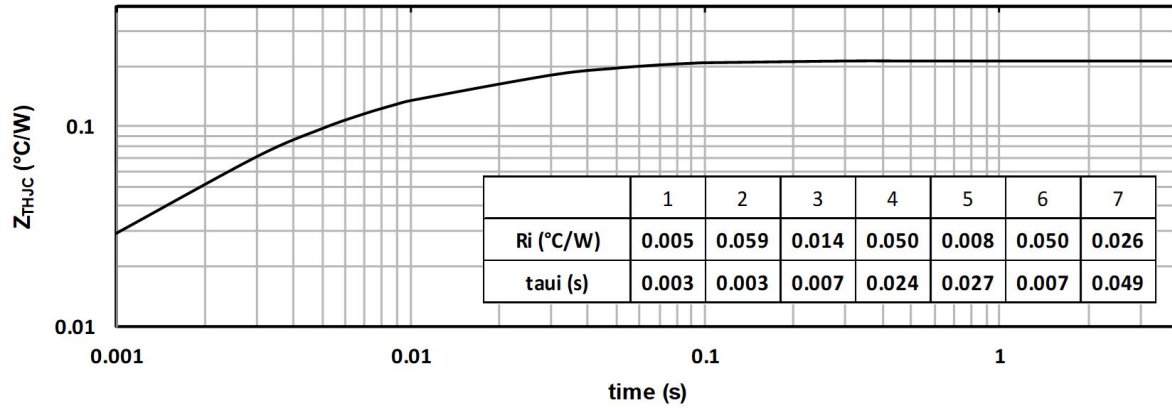
Figure 14. Operating Frequency vs Drain Current



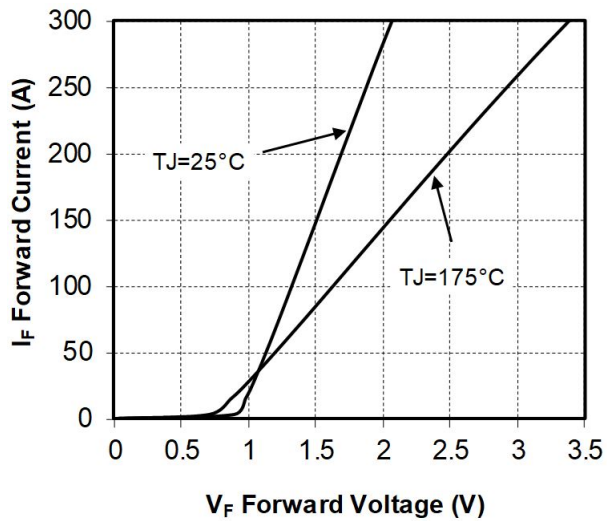
## Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM120TLM11CAG device.

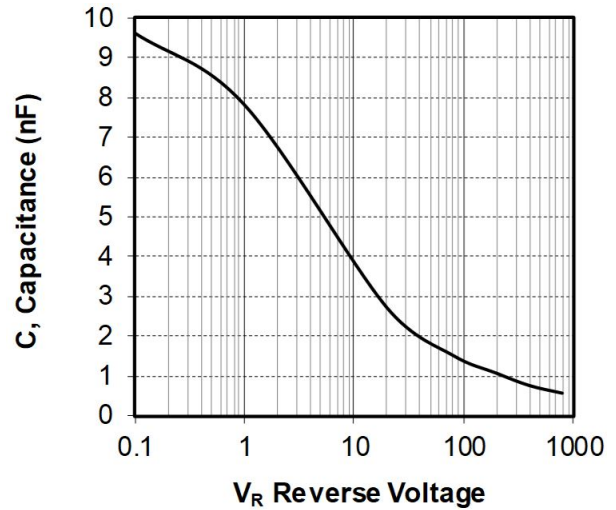
**Figure 15. Maximum Thermal Impedance**



**Figure 16. Forward Characteristics**



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





## Revision History

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

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ISBN: 978-1-5224-9523-9

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