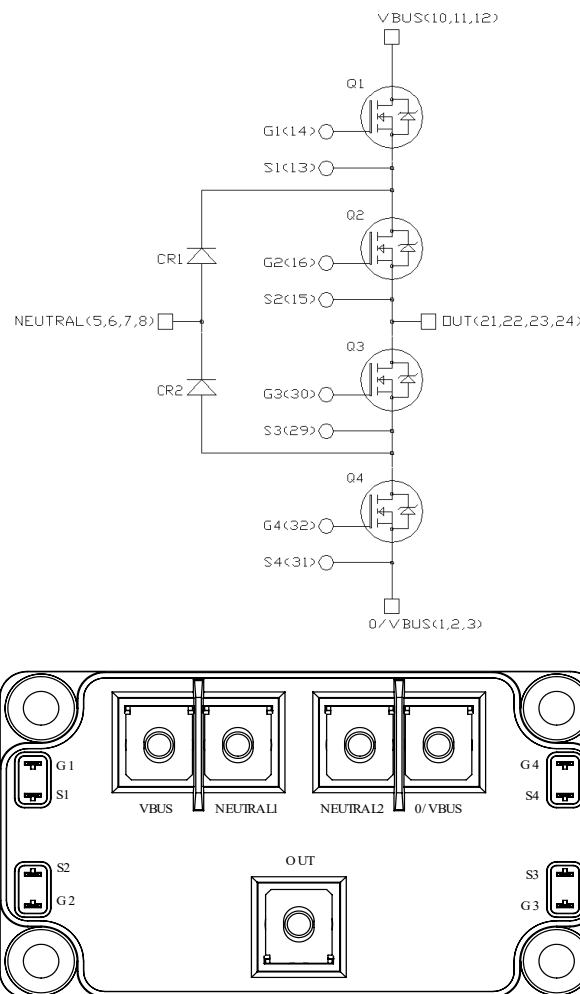


Three Level Inverter SiC MOSFET Power Module

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_{DS}	Drain-Source voltage		1700	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	238	A
		$T_C = 80\text{ }^{\circ}\text{C}$	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 Ω
P_D	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	1114	W

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	μA
$R_{DS(on)}$	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 Ω
			$T_J = 175\text{ }^{\circ}\text{C}$	—	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	$V_{GS} = -5\text{V}/20\text{V}$	$T_J = 150\text{ °C}$	—	75	—	ns
T_r	Rise time	$V_{Bus} = 900\text{V}$		—	75	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 200\text{A}$		—	153	—	
T_f	Fall time	$R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$		—	56	—	
E_{on}	Turn-on energy	$V_{GS} = -5\text{ V}/20\text{V}$	$T_J = 150\text{ °C}$	—	9	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 900\text{V}$ $I_D = 200\text{A}$ $R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$	$T_J = 150\text{ °C}$	—	4.8	—	
R_{Gint}	Internal gate resistance			—	1.46	—	Ω
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	$V_R = 1700V$	$T_J = 25\text{ }^{\circ}C$	—	40	800	μA
			$T_J = 175\text{ }^{\circ}C$	—	600	—	
I_F	DC forward current	—	$T_C = 125\text{ }^{\circ}C$	—	120	—	A
V_F	Diode forward voltage	$I_F = 120A$	$T_J = 25\text{ }^{\circ}C$	—	1.5	1.8	V
			$T_J = 175\text{ }^{\circ}C$	—	2.3	—	
Q_C	Total capacitive charge	$V_R = 900V$		—	920	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600V$		—	668	—	pF
		$f = 1\text{ MHz}, V_R = 900V$		—	552	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.149	$^{\circ}C/W$

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	$^{\circ}C$
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	N.m
		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

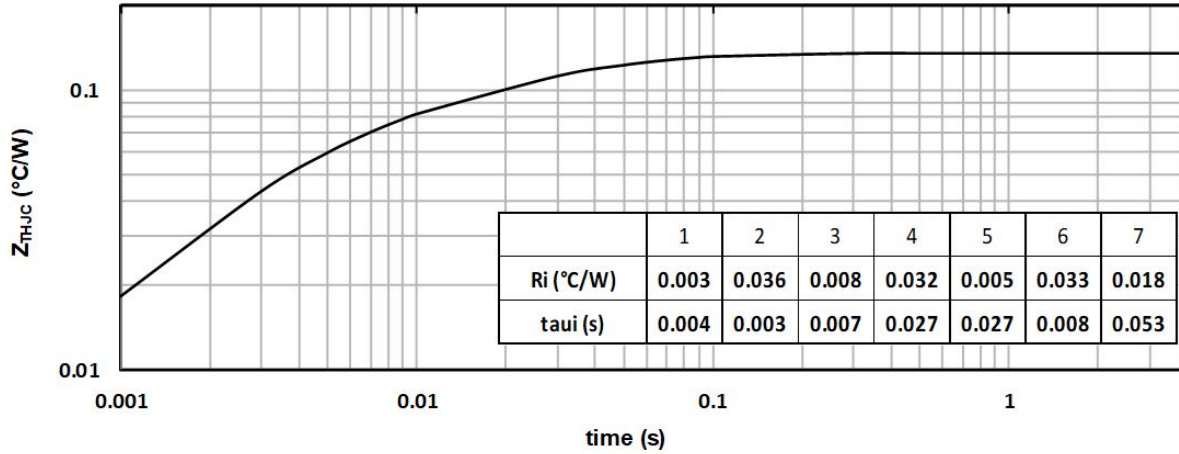


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

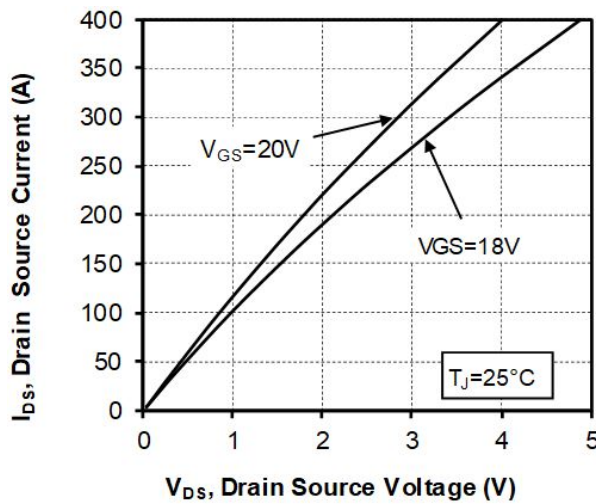


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

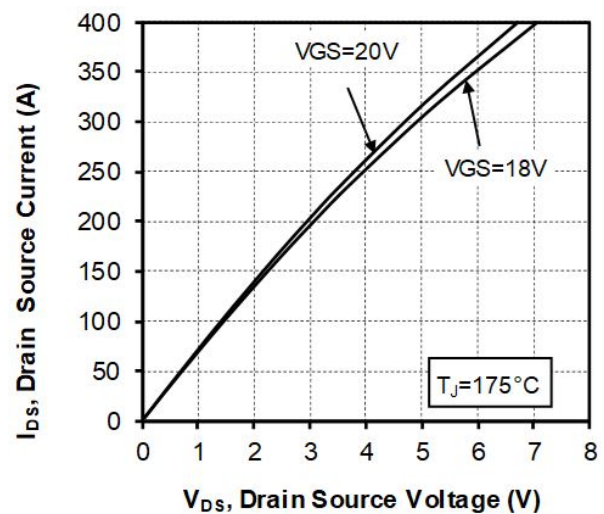


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

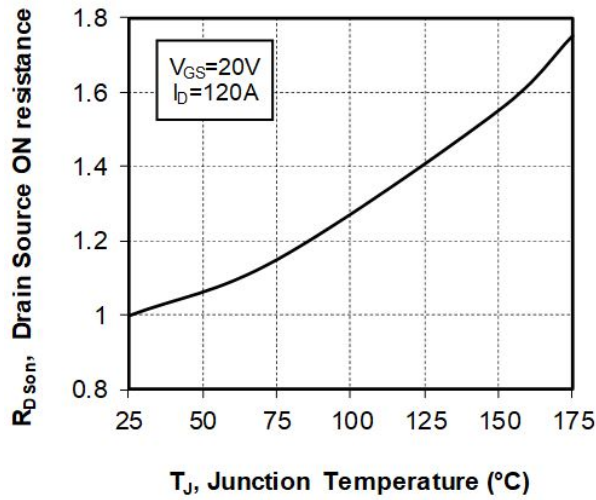


Figure 1-5. Transfer Characteristics

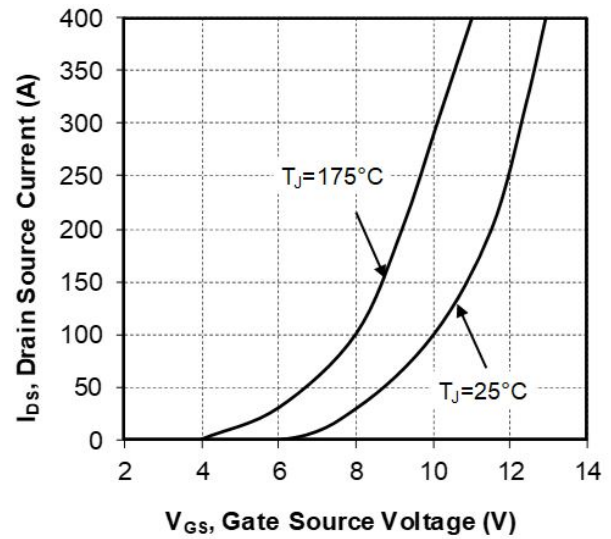


Figure 1-6. Switching Energy vs. R_g

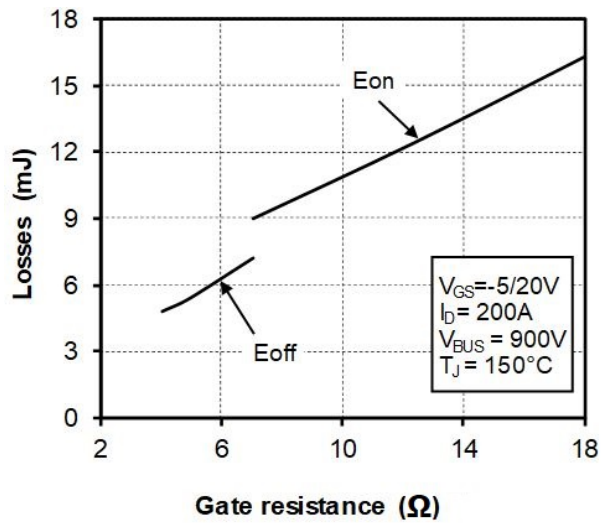


Figure 1-7. Switching Energy vs. Current

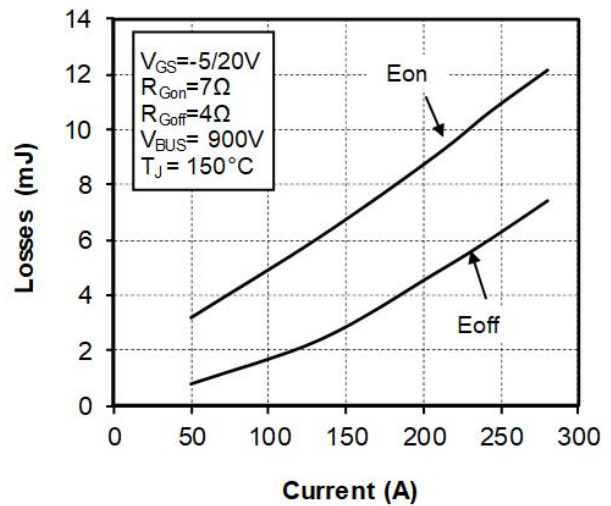


Figure 1-8. Capacitance vs. Drain Source Voltage

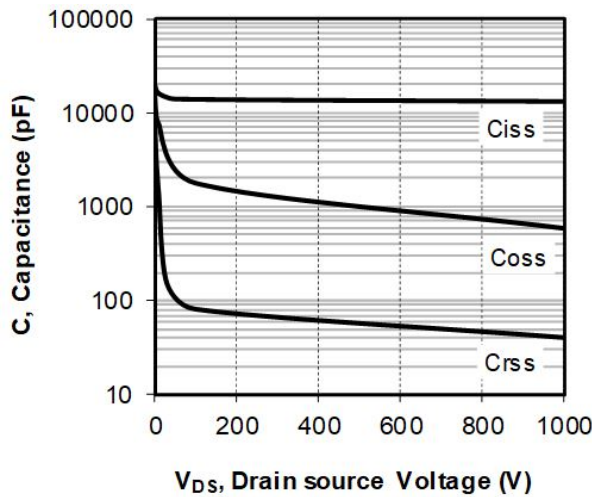


Figure 1-9. Gate Charge vs. Gate Source Voltage

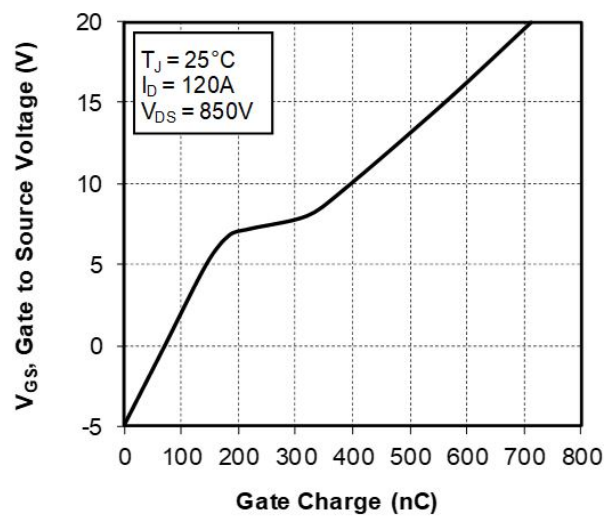


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

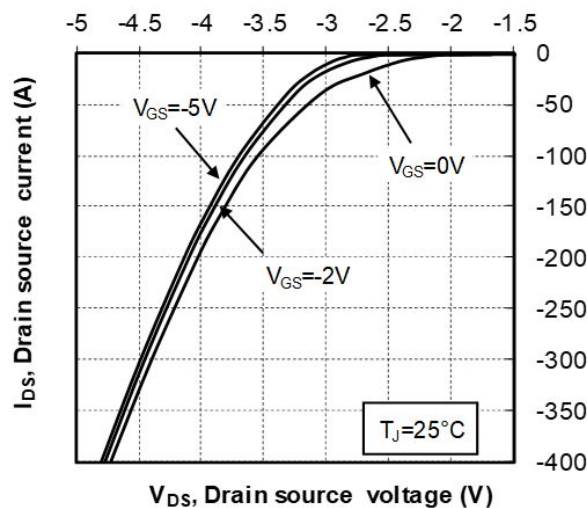


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

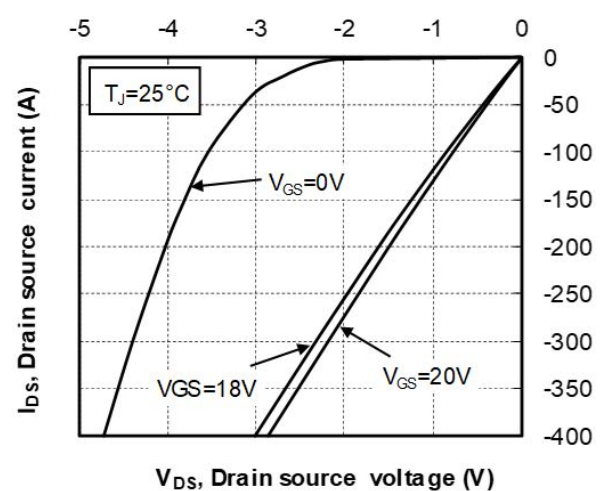


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

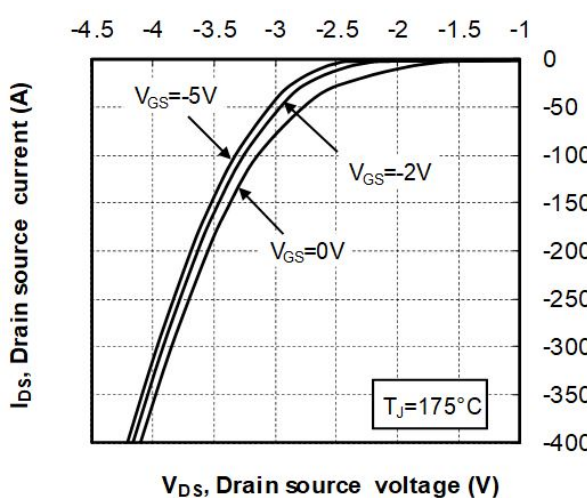


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

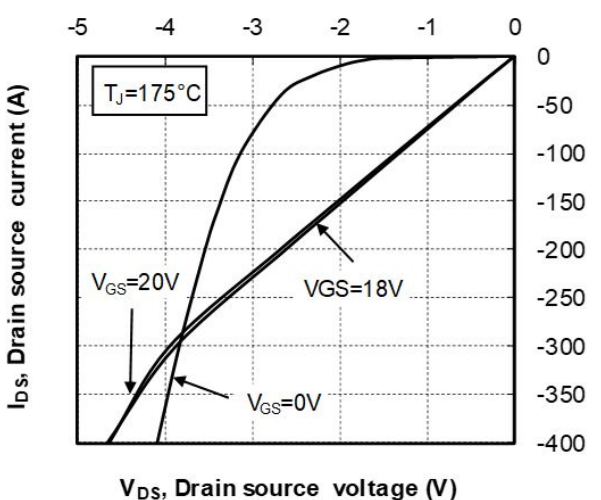
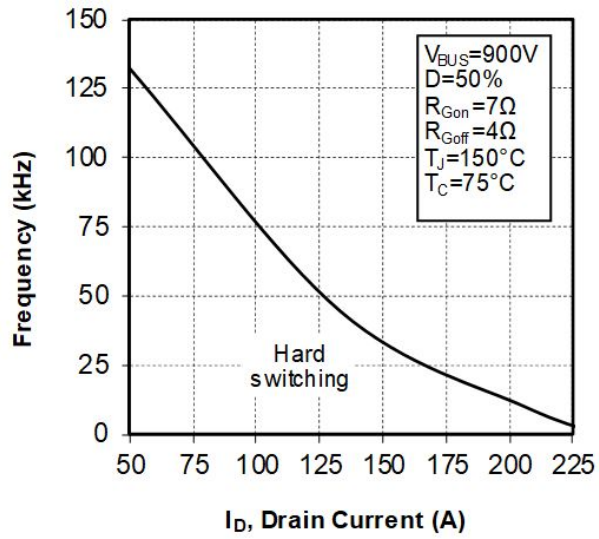


Figure 1-14. Operating Frequency vs Drain Current



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

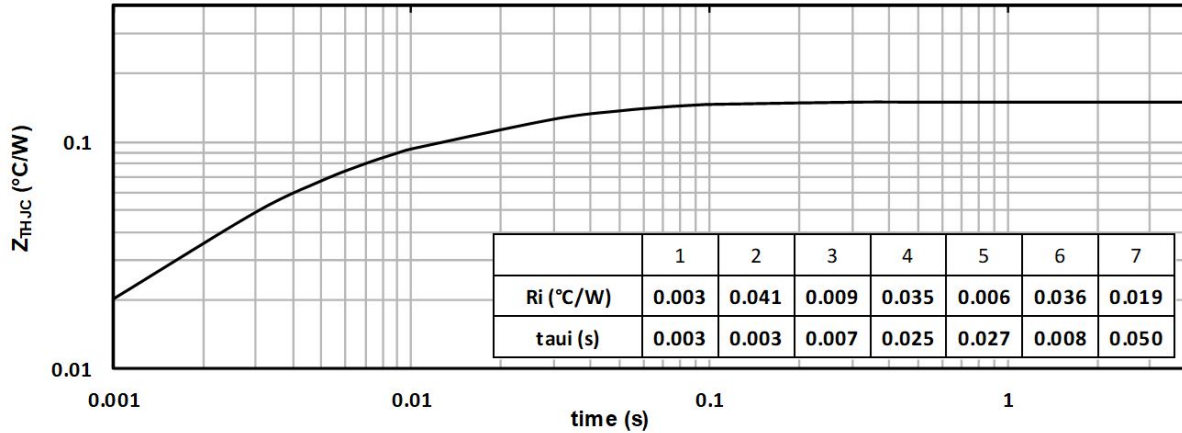


Figure 1-16. Forward Characteristics

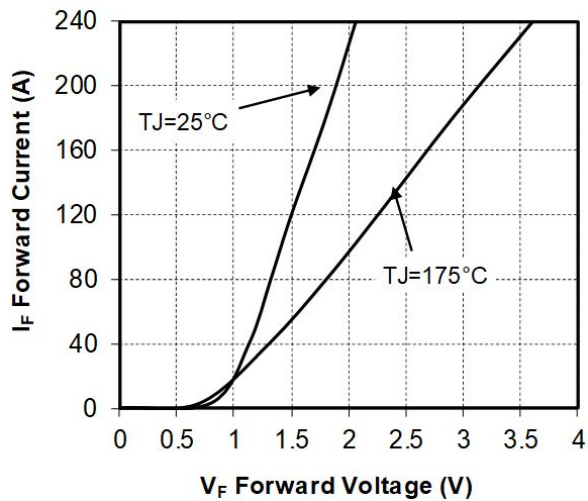
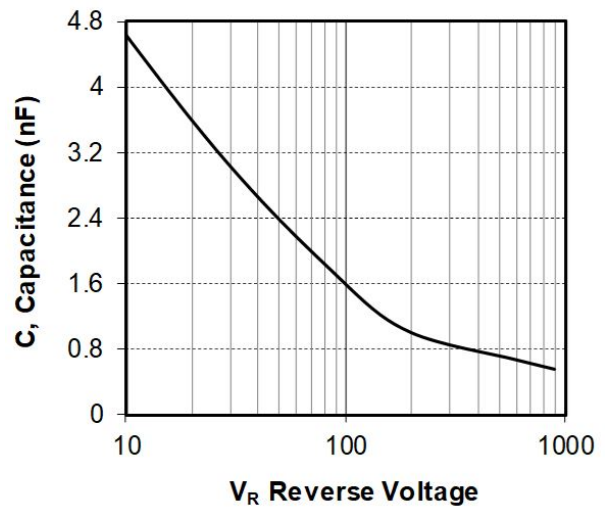


Figure 1-17. Capacitance vs. Reverse Voltage



The following section shows the package specification of the MSCSM170TLM11CAG device.

The following figure shows the package outline drawing of the MSCSM170TLM11CAG device. The dimensions in the following figure are in millimeters.

[illegible]

3. Revision History

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

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