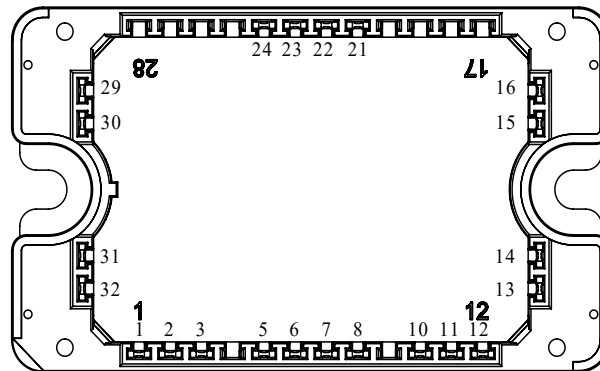
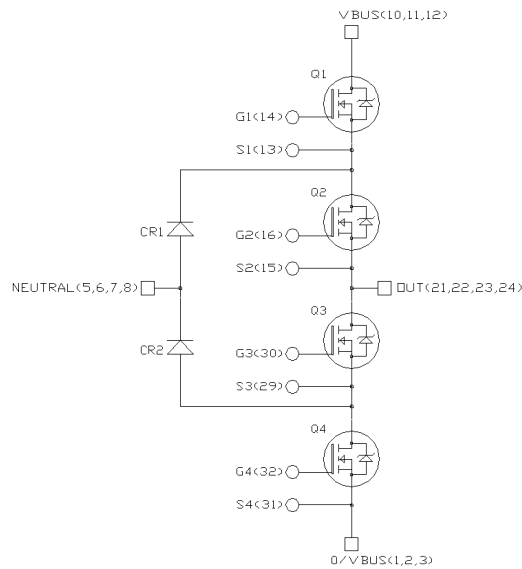


## Three Level Inverter SiC MOSFET Power Module

### Product Overview

The MSCSM120TLM50C3AG device is a 1200V/55A three level inverter silicon carbide (SiC) MOSFET power module.



#### Note:

1. All ratings at  $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise specified.
2. All multiple inputs and outputs must be shorted together: 1/2/3 ; 10/11/12 ; 5/6/7/8 ; 21/22/23/24



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

## Features

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The following are the key features of MSCSM120TLM50C3AG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High temperature performance
- SiC Schottky Diode (CR1 and CR2)
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF
- Kelvin source for easy drive
- Low stray inductance
- High level of integration
- AlN substrate for improved thermal performance

## Benefits

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The following are the benefits of MSCSM120TLM50C3AG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS compliant

## Application

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The following are the applications of MSCSM120TLM50C3AG device:

- Uninterruptible power supplies

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120TLM50C3AG device.

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

The following table lists the absolute maximum ratings of MSCSM120TLM50C3AG device.

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

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	55
		$T_C = 80\text{ }^\circ\text{C}$	44
$I_{DM}$	Pulsed drain current	110	
$V_{GSmax}$	Gate-Source voltage	-10/25	V
$R_{DS(on)}$	Drain-Source ON resistance	50	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	245

The following table lists the electrical characteristics of MSCSM120TLM50C3AG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$	—	10	100	$\mu A$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 40A$	$T_J = 25\text{ }^\circ\text{C}$	—	40	50
			$T_J = 175\text{ }^\circ\text{C}$	—	64	—
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 1\text{ mA}$	1.8	2.7	—	V
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20V$ $V_{DS} = 0V$	—	—	150	nA

# MSCSM120TLM50C3AG

## Electrical Specifications

The following table lists the dynamic characteristics of MSCSM120TLM50C3AG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>GS</sub> = 0V	—	1990	—	pF
C <sub>oss</sub>	Output capacitance	V <sub>DS</sub> = 1000V	—	156	—	
C <sub>rss</sub>	Reverse transfer capacitance	f = 1 MHz	—	17	—	
Q <sub>g</sub>	Total gate charge	V <sub>GS</sub> = -5V/20V	—	137	—	nC
Q <sub>gs</sub>	Gate-Source charge	V <sub>Bus</sub> = 800V	—	29	—	
Q <sub>gd</sub>	Gate-Drain charge	I <sub>D</sub> = 40A	—	31	—	
T <sub>d(on)</sub>	Turn-on delay time	V <sub>GS</sub> = -5V/20V	—	30	—	ns
T <sub>r</sub>	Rise time	V <sub>Bus</sub> = 600V		40	—	
T <sub>d(off)</sub>	Turn-off delay time	I <sub>D</sub> = 40A		60	—	
T <sub>f</sub>	Fall time	R <sub>Gon</sub> = 10Ω R <sub>Goff</sub> = 5.8Ω		20	—	
E <sub>on</sub>	Turn-on energy	V <sub>GS</sub> = -5V/20V	—	0.8	—	mJ
E <sub>off</sub>	Turn-off energy	V <sub>Bus</sub> = 600V I <sub>D</sub> = 40A R <sub>Gon</sub> = 10Ω R <sub>Goff</sub> = 5.8Ω	—	0.53	—	
R <sub>Gint</sub>	Internal gate resistance		—	1.2	—	Ω
R <sub>thJC</sub>	Junction-to-case thermal resistance		—	—	0.61	°C/W

The following table lists the body diode ratings and characteristics of MSCSM120TLM50C3AG device.

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

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>SD</sub>	Diode forward voltage	V <sub>GS</sub> = 0V I <sub>SD</sub> = 40A	—	4	—	V
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 40A	—	100	—	ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>GS</sub> = -5V	—	550	—	nC
I <sub>rr</sub>	Reverse recovery current	V <sub>R</sub> = 800V di <sub>F</sub> /dt = 1000 A/μs	—	13	—	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 MSCSM120TLM50C3AG device.

**Table 1-5. CR1 and CR2 SiC Diode Ratings and Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
$V_{RRM}$	Peak repetitive reverse voltage		—	—	1200	V	
$I_{RM}$	Reverse leakage current	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$	—	10	200	$\mu\text{A}$
			$T_J = 175\text{ °C}$	—	150	—	
$I_F$	DC forward current		$T_C = 100\text{ °C}$	—	30	—	A
$V_F$	Diode forward voltage	$I_F = 30\text{ A}$	$T_J = 25\text{ °C}$	—	1.5	1.8	V
			$T_J = 175\text{ °C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$	—	130	—	nC	
C	Total capacitance	$f = 1\text{ MHz}$ $V_R = 400\text{ V}$	—	141	—	pF	
		$f = 1\text{ MHz}$ $V_R = 800\text{ V}$	—	105	—		
$R_{thJH}$	Junction-to-heatsink thermal resistance		—	—	0.9	$^{\circ}\text{C/W}$	

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120TLM50C3AG device.

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

Symbol	Characteristic	Min.	Max.	Unit		
V <sub>ISOL</sub>	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/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 case temperature	-40	125			
T <sub>C</sub>	Operating case temperature	-40	125			
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package weight	—	110	g		

### 1.4 Typical SiC MOSFET Performance Curve (Per SiC MOSFET)

This section shows the typical SiC MOSFET performance curves of the MSCSM120TLM50C3AG device.

**Figure 1-1. Junction-to-Heatsink Thermal Impedance**

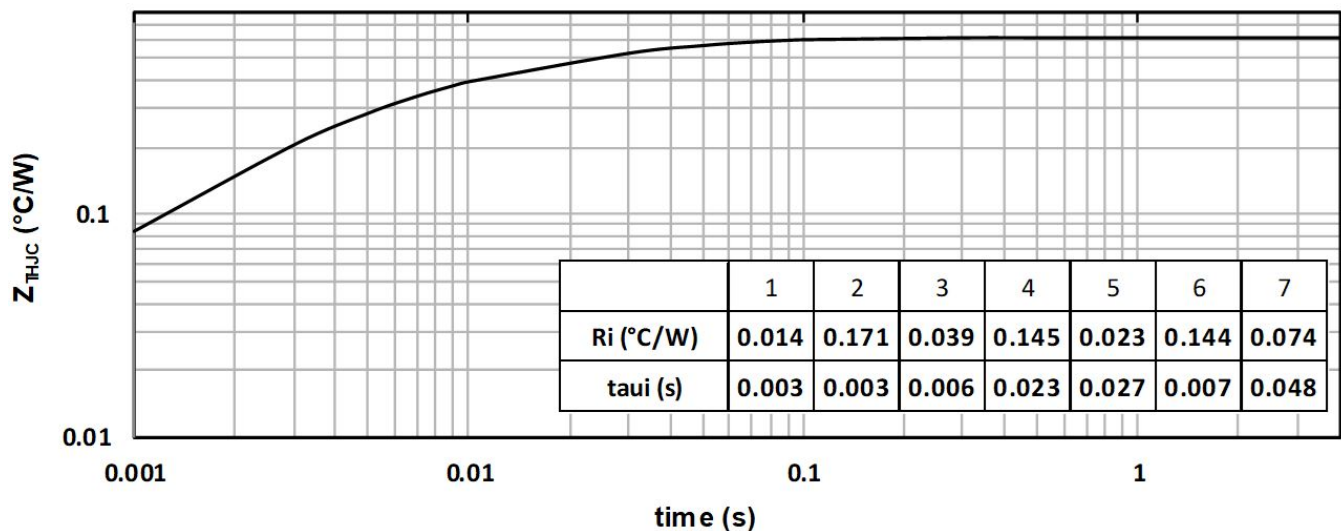


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

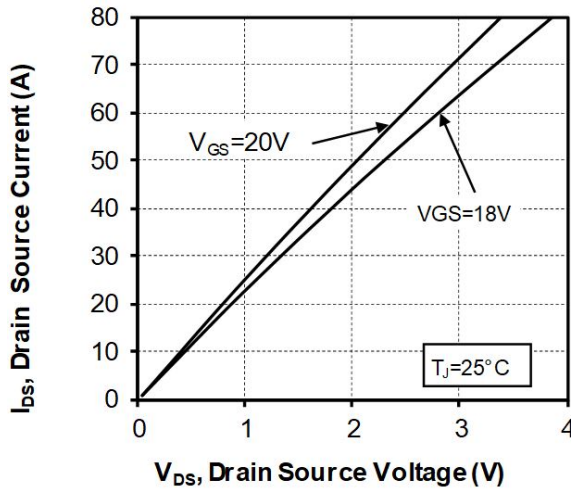


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

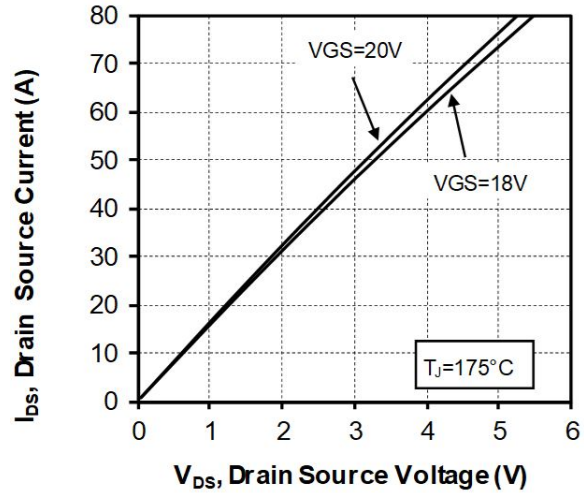


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

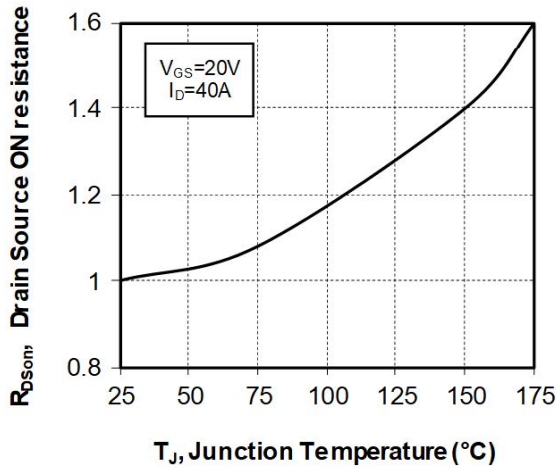


Figure 1-5. Transfer Characteristics

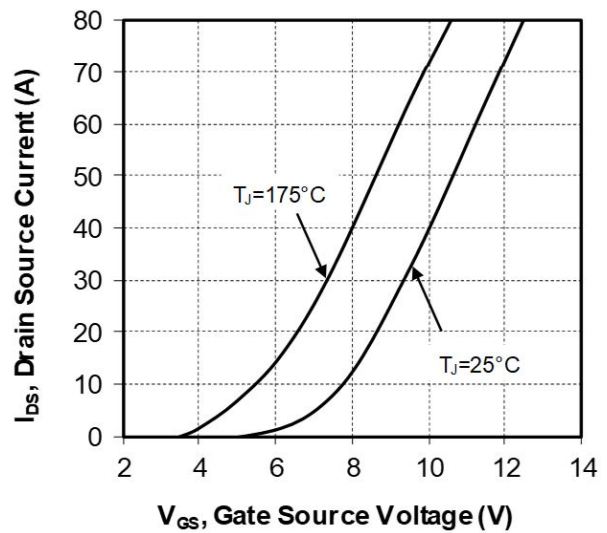


Figure 1-6. Switching Energy vs.  $R_g$

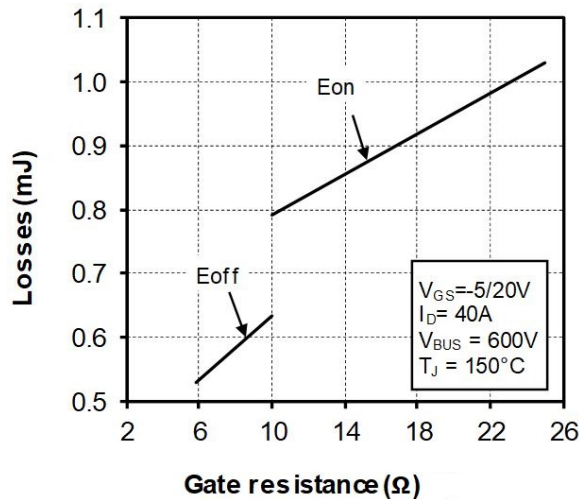


Figure 1-7. Switching Energy vs. Current

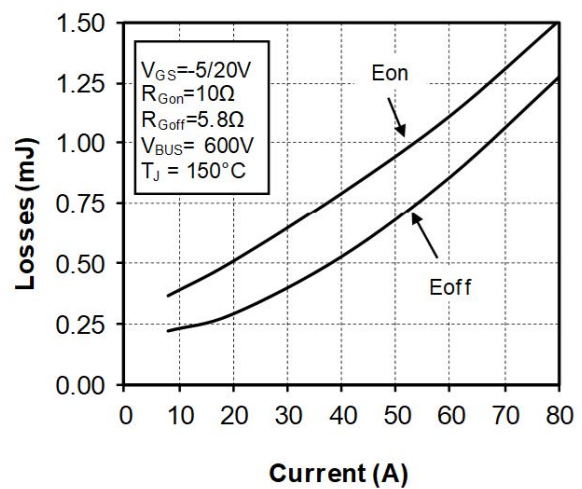


Figure 1-8. Capacitance vs. Drain Source Voltage

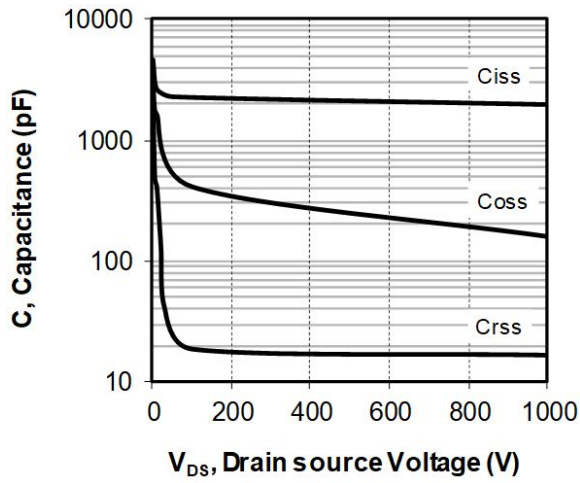


Figure 1-9. Gate Charge vs. Gate Source Voltage

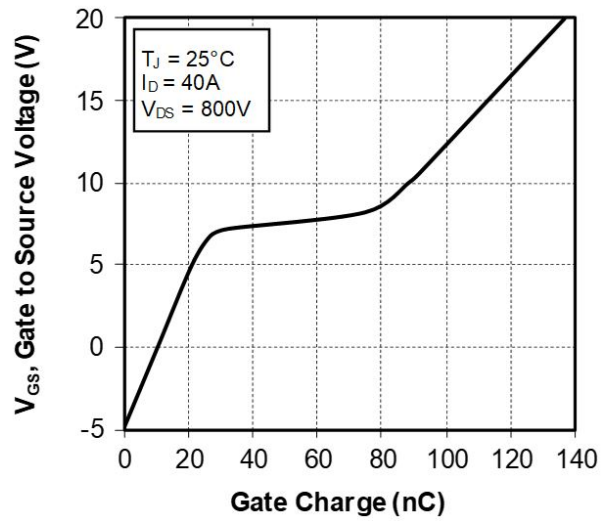


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

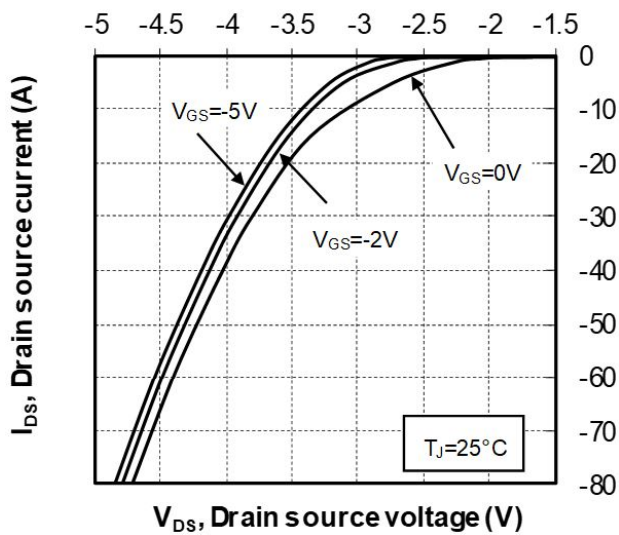


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

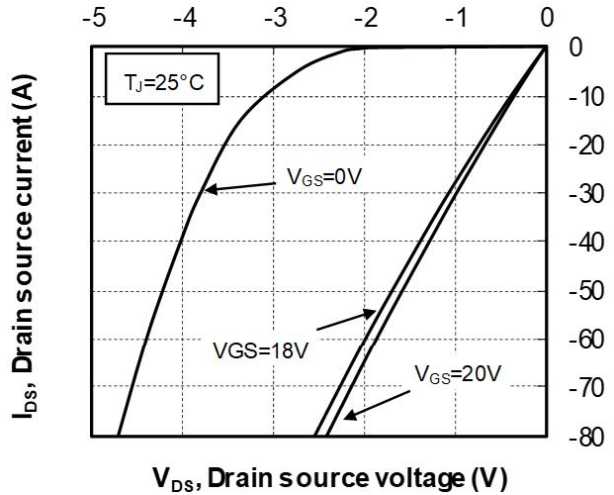




Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

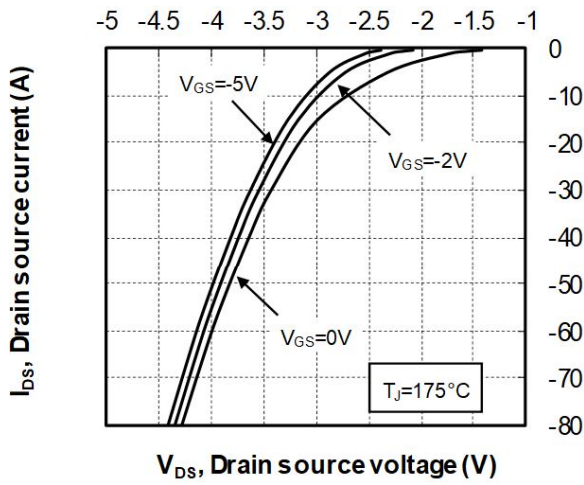


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

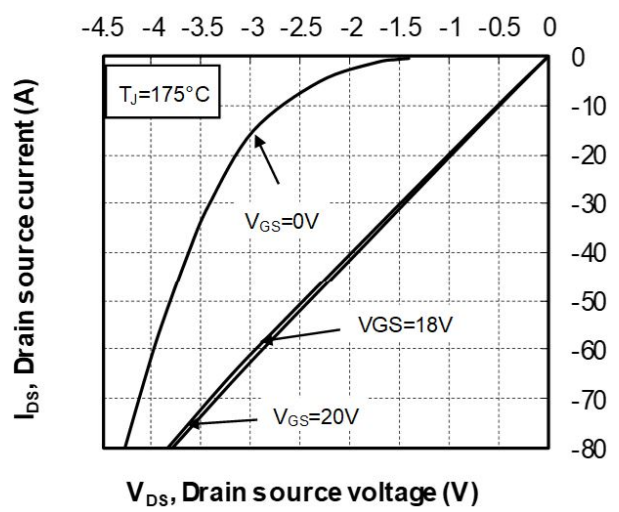
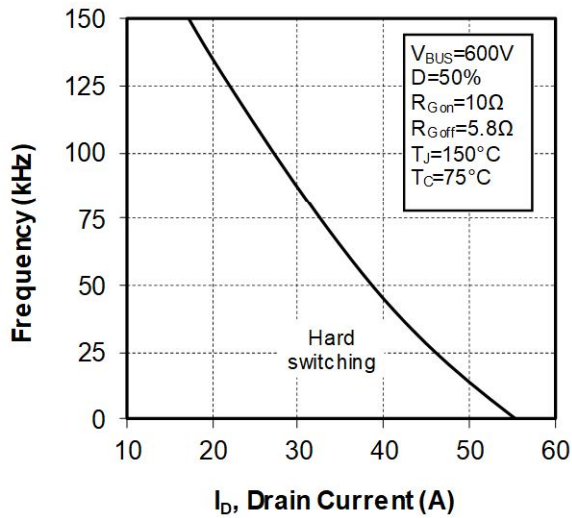


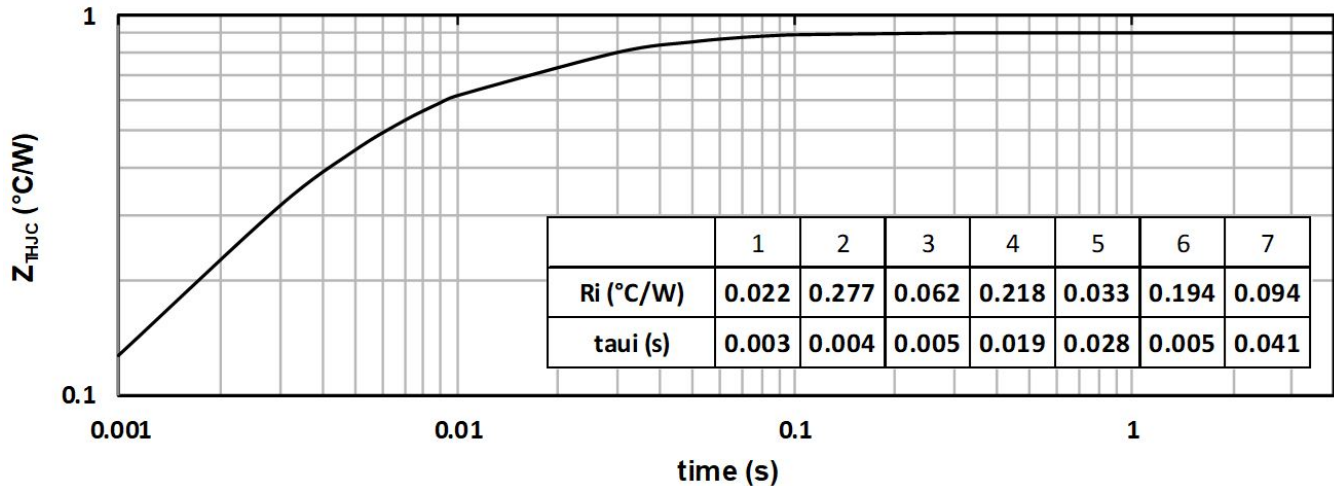
Figure 1-14. Operating Frequency vs. Drain Current



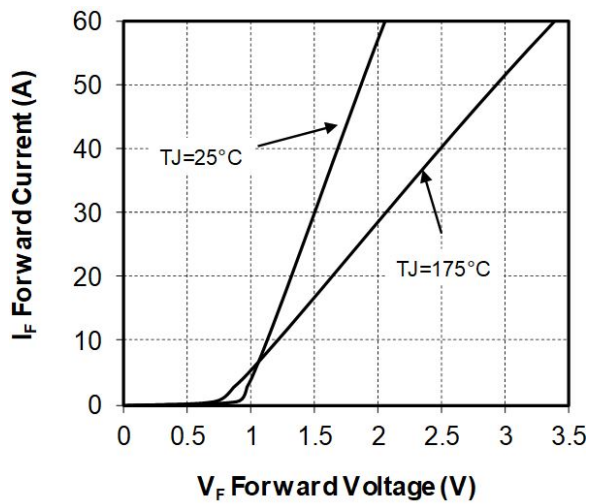
### 1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM120TLM50C3AG device.

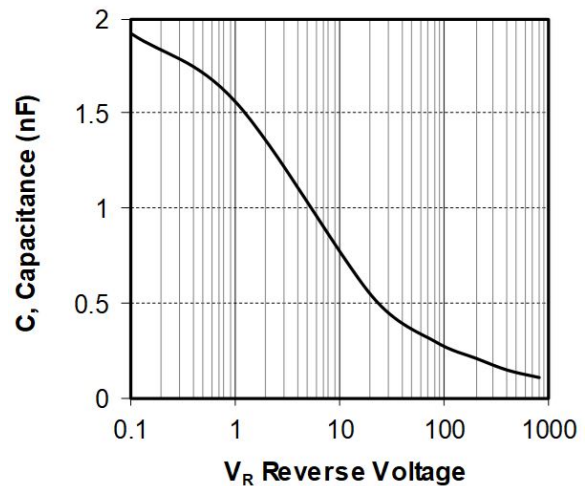
**Figure 1-15. Junction-to-Heatsink Thermal Impedance**



**Figure 1-16. Forward Characteristics**



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



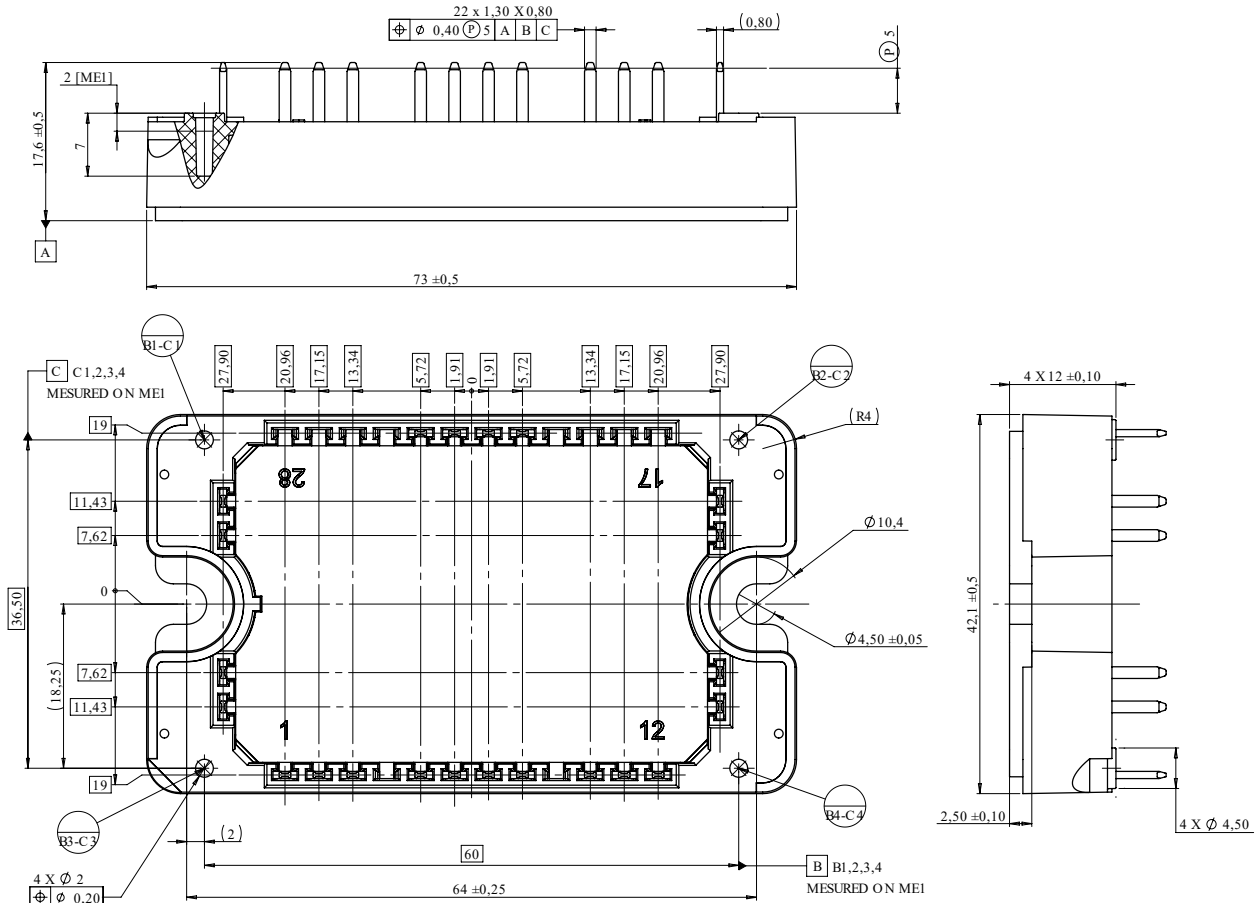
## 2. Package Specifications

The following section shows the package specification of the device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120TLM50C3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



**Note:** See application note [AN3500A—Mounting instructions for SP1F and SP3F power modules](#).

### 3. Revision History

Revision	Date	Description
A	12/2021	Initial Revision

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ISBN: 978-1-5224-9526-0

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