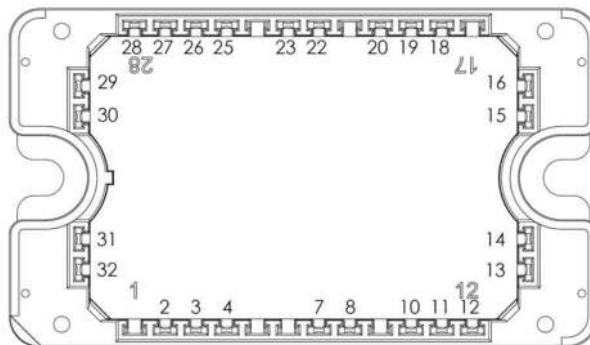
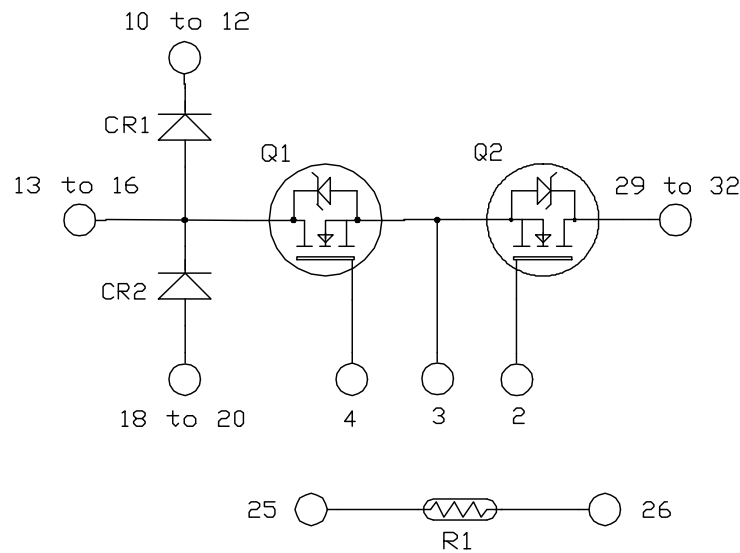


## Vienna Rectifier SiC MOSFET Power Module

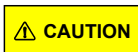
### Product Overview

The MSCSM70VR1M10CT3AG device is a Vienna rectifier 700V, 241A silicon carbide (SiC) power module.



**Notes:**

- All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified.
- All multiple inputs and outputs must be shorted together: 10 to 12; 13 to 16; 18 to 20; 29 to 32.



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 MSCSM70VR1M10CT3AG 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  $V_F$
- Kelvin source for easy drive
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

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The following are the benefits of MSCSM70VR1M10CT3AG device:

- Outstanding performance at high frequency operation
- High-power and high-efficiency rectifiers and converters
- 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 MSCSM70VR1M10CT3AG device is designed for the following applications:

- Power factor correction
- Switched mode power supplies
- Uninterruptible power supplies

### 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM70VR1M10CT3AG device.

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

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

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

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	241 <sup>1</sup>
		$T_C = 80\text{ }^\circ\text{C}$	192 <sup>1</sup>
$I_{DM}$	Pulsed drain current	482	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	9.5	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	690

**Note:**

1. Specification of SiC MOSFET device but output current must be limited due to size of power connectors.

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 700V$	—	—	200	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 80A$	$T_J = 25\text{ }^\circ\text{C}$	—	7.5	9.5
			$T_J = 175\text{ }^\circ\text{C}$	—	9.5	—
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 8\text{ mA}$	1.9	2.4	—	V
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20V; V_{DS} = 0V$	—	—	200	nA

# MSCSM70VR1M10CT3AG

## Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
$C_{iss}$	Input capacitance	$V_{GS} = 0V$	—	9000	—	pF	
$C_{oss}$	Output capacitance	$V_{DS} = 700V$	—	1020	—		
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	58	—		
$Q_g$	Total gate charge	$V_{GS} = -5V/20V$	—	430	—	nC	
$Q_{gs}$	Gate-Source charge	$V_{Bus} = 470V$	—	116	—		
$Q_{gd}$	Gate-Drain charge	$I_D = 80A$	—	70	—		
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^\circ\text{C}$	—	40	—	ns
$T_r$	Rise time	$V_{Bus} = 400V$		—	35	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 160A$		—	50	—	
$T_f$	Fall time	$R_{G(on)} = 13.5\Omega$ $R_{G(off)} = 2.4\Omega$		—	20	—	
$E_{on}$	Turn-on energy	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^\circ\text{C}$	—	1090	—	$\mu\text{J}$
$E_{off}$	Turn-off energy	$V_{Bus} = 400V$ $I_D = 160A$ $R_{G(on)} = 13.5\Omega$ $R_{G(off)} = 2.4\Omega$	$T_J = 150\text{ }^\circ\text{C}$	—	372	—	
$R_{Gint}$	Internal gate resistance		—	2.8	—	$\Omega$	
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.217	$^\circ\text{C/W}$	

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

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

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0V; I_{SD} = 80A$	—	3.4	—	V
		$V_{GS} = -5V; I_{SD} = 80A$	—	3.8	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 80A; V_{GS} = -5V$	—	38	—	ns
$Q_{rr}$	Reverse recovery charge	$V_R = 400V; di_F/dt = 2000\text{ A}/\mu\text{s}$	—	636	—	nC
$I_{rr}$	Reverse recovery current		—	29.6	—	A

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

The following table lists the SiC diode ratings and characteristics of MSCSM70VR1M10CT3AG device.

**Table 1-5. 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	$V_R = 1200V$	$T_J = 25\text{ }^\circ\text{C}$	—	30	400	$\mu\text{A}$
			$T_J = 175\text{ }^\circ\text{C}$	—	500	—	
$I_F$	DC forward current						
$V_F$	Diode forward voltage	$I_F = 100A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600V$	—	448	—	nC	
C	Total capacitance	$f = 1\text{ MHz}$ $V_R = 400V$	—	492	—	pF	
		$f = 1\text{ MHz}$ $V_R = 800V$	—	364	—		
$R_{thJH}$	Junction-to-case thermal resistance		—	—	0.297	$^\circ\text{C/W}$	

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM70VR1M10CT3AG 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 temperature range	−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

The following table lists the temperature sensor NTC of the MSCSM70VR1M10CT3AG device.

**Table 1-7. Temperature Sensor NTC**

Symbol	Characteristic	Min.	Typ.	Max.	Unit
R <sub>25</sub>	Resistance at 25 °C	—	50	—	kΩ
ΔR <sub>25</sub> /R <sub>25</sub>	—	—	5	—	%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15 K	—	3952	—	K
ΔB/B	—	T <sub>C</sub> = 100 °C	4	—	%

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right]}$$

T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

**Note:** See [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#) for more information.

### 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70VR1M10CT3AG device.

Figure 1-1. Maximum Thermal Impedance

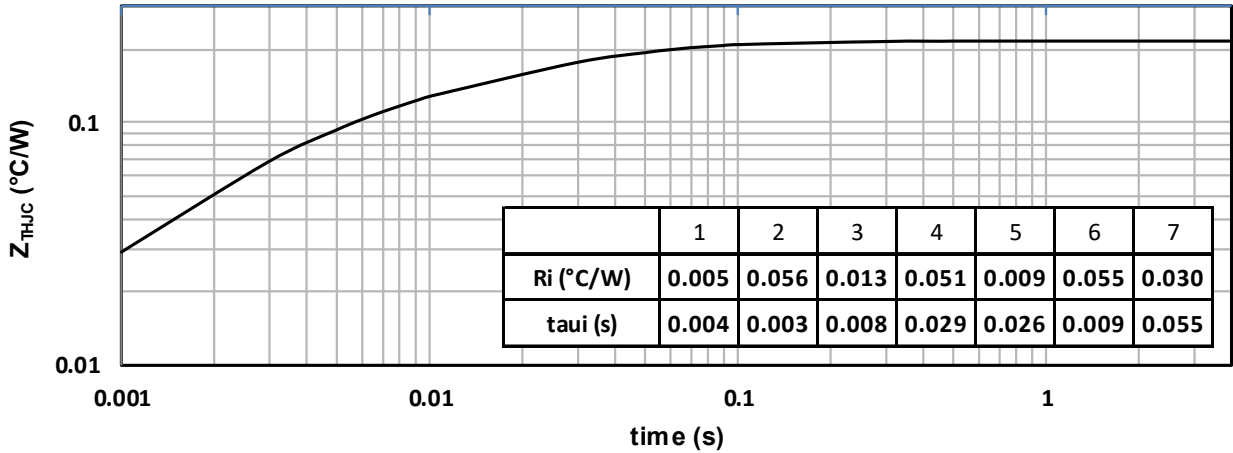


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

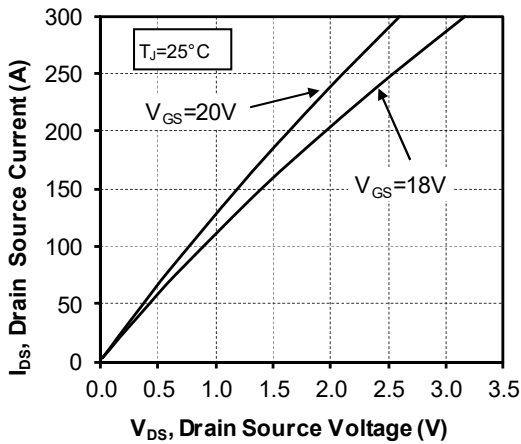


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

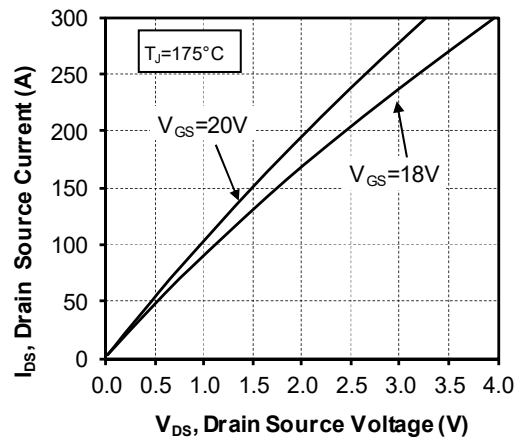


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

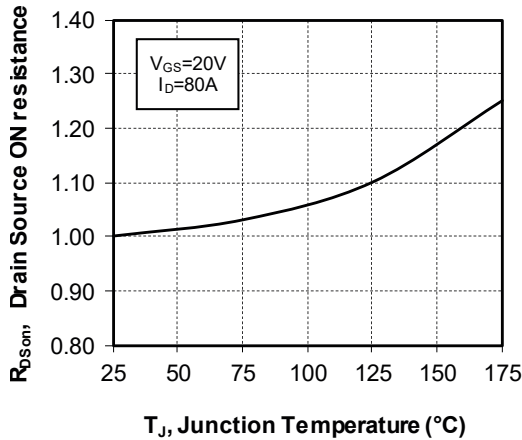
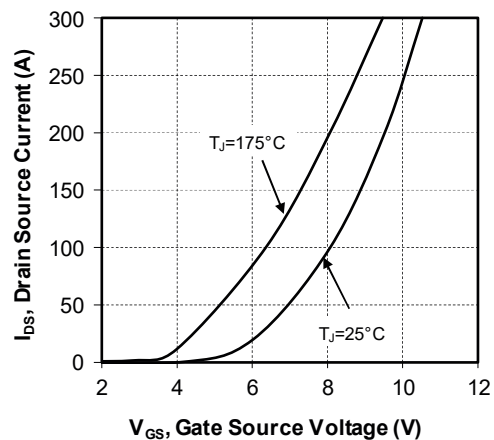


Figure 1-5. Transfer Characteristics



# MSCSM70VR1M10CT3AG

## Electrical Specifications

Figure 1-6. Switching Energy vs. Current

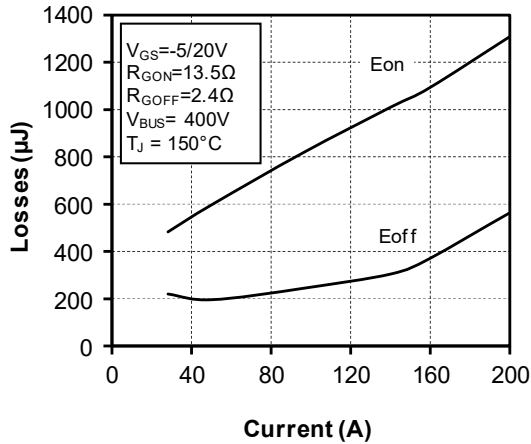


Figure 1-7. Turn On Energy vs.  $R_g$

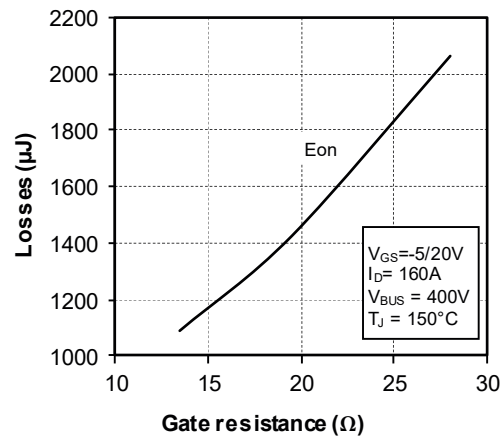


Figure 1-8. Capacitance vs. Drain Source Voltage

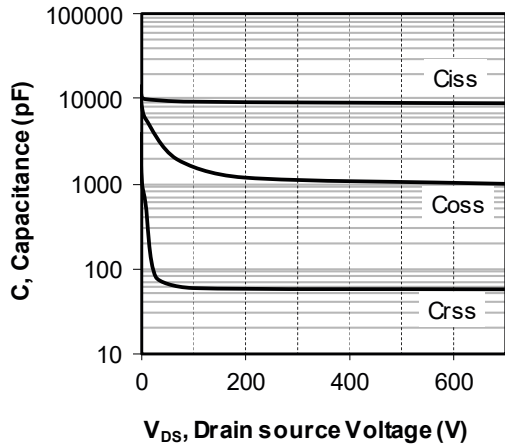


Figure 1-9. Gate Charge vs. Gate Source Voltage

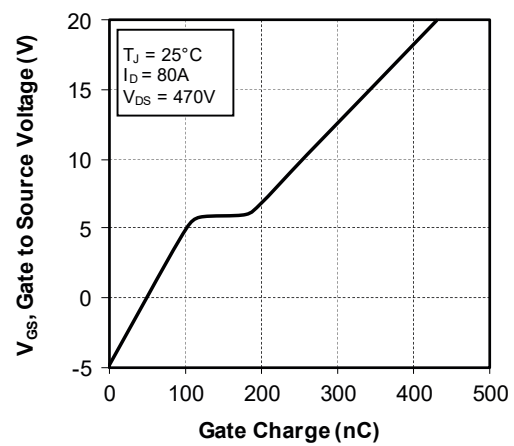


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

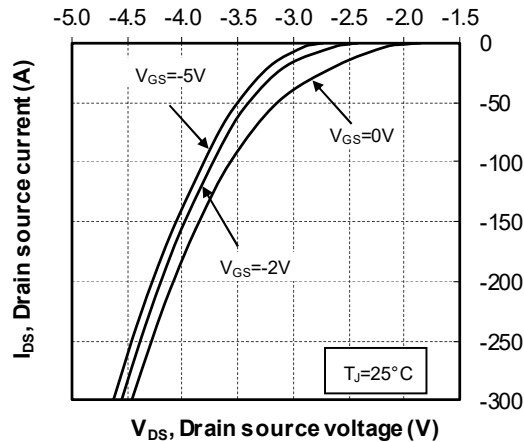
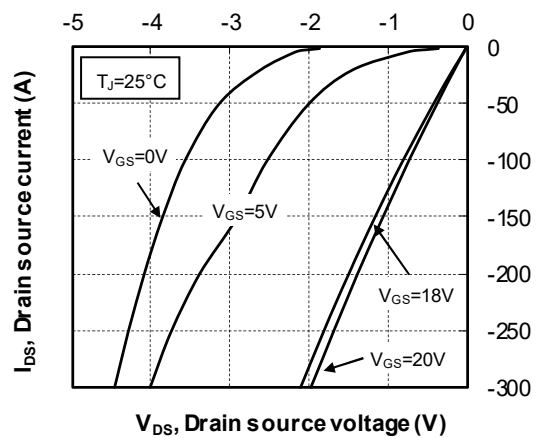


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$





# MSCSM70VR1M10CT3AG

## Electrical Specifications

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

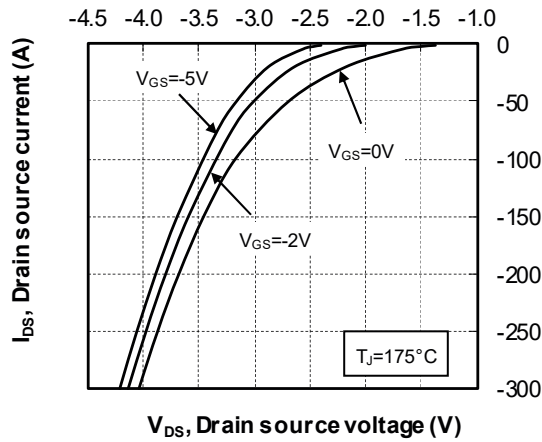


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

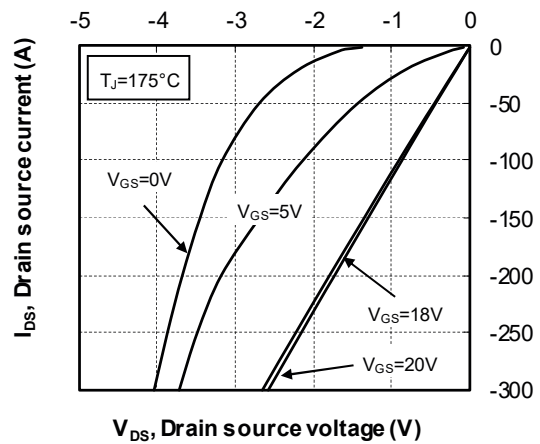


Figure 1-14. Operating Frequency vs Drain Current

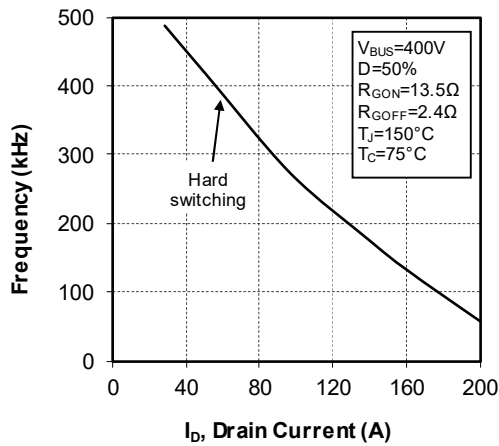
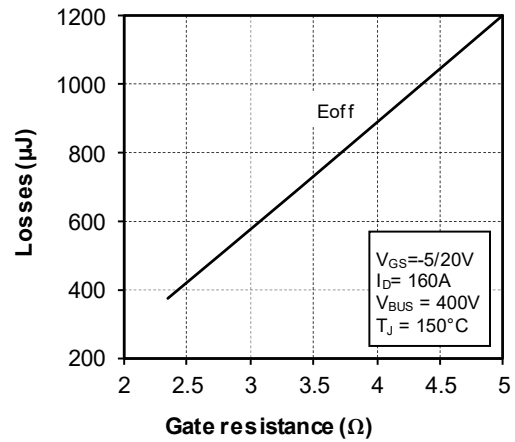


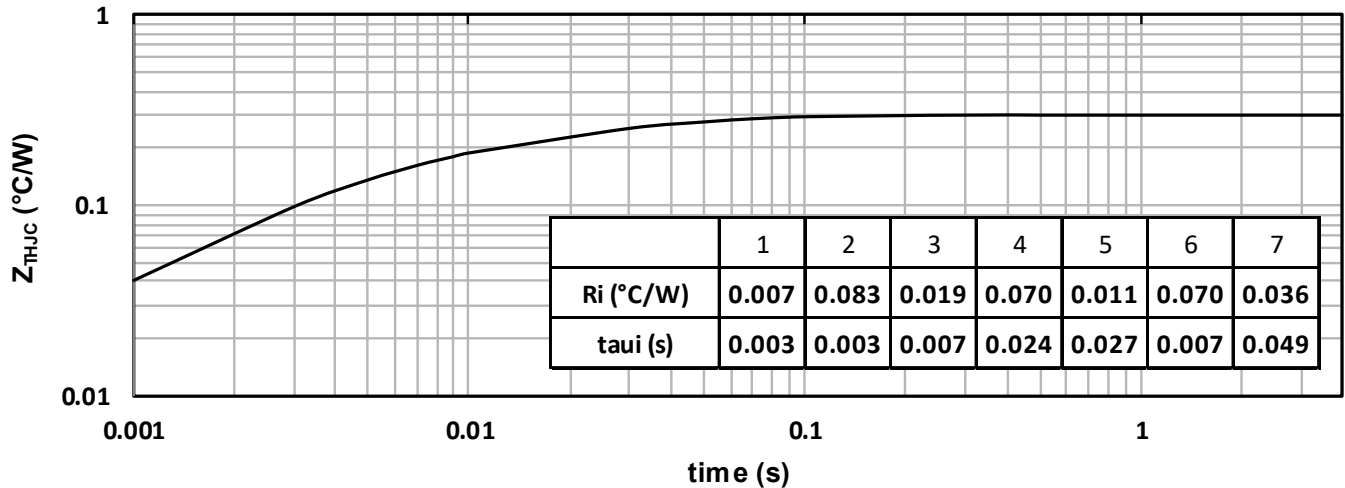
Figure 1-15. Turn Off Energy vs. Rg



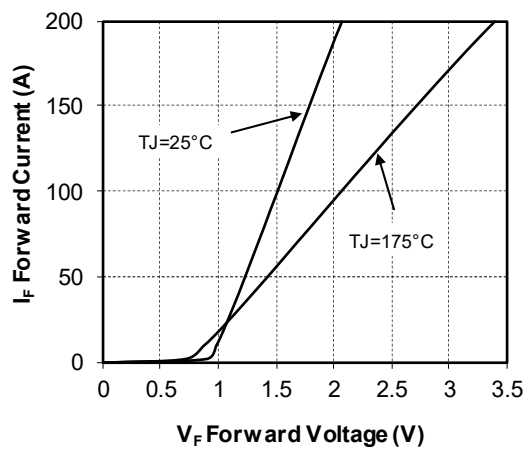
### 1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM70VR1M10CT3AG device.

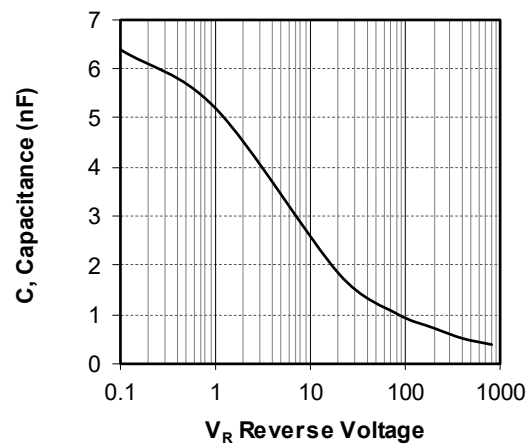
**Figure 1-16. Maximum Thermal Impedance**



**Figure 1-17. Forward Characteristics**



**Figure 1-18. Capacitance vs. Reverse Voltage**



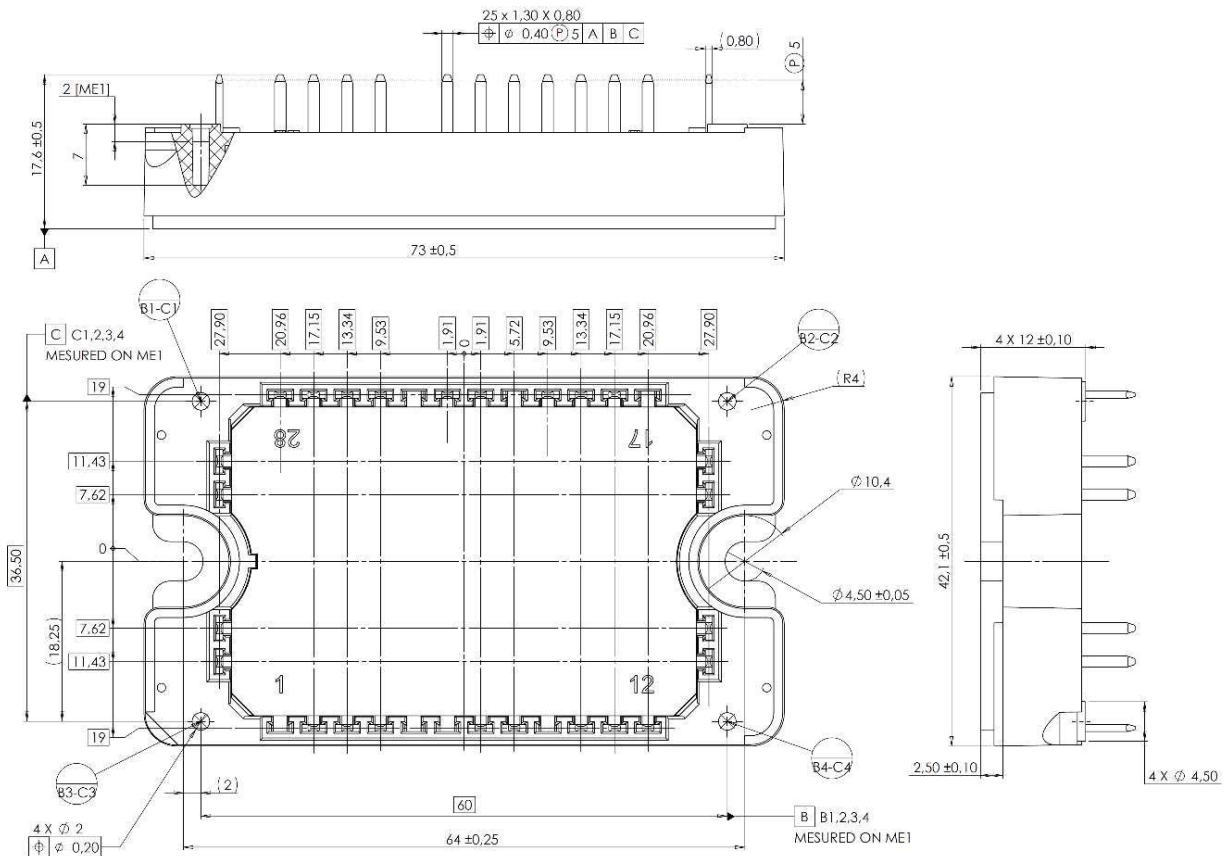
## 2. Package Specifications

The following section shows the package specification of the MSCSM70VR1M10CT3AG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70VR1M10CT3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



**Note:** See [AN3500A—Mounting Instructions for SP1F and SP3F Power Modules](#) application note for more information.

### 3. Revision History

Revision	Date	Description
A	08/2022	Initial Revision

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