

**MSCSM70AM10CT3AG**  
**Datasheet**  
**Phase Leg SiC MOSFET Power Module**

April 2020



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a  **MICROCHIP** company

# Contents

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<b>1 Revision History.....</b>	<b>1</b>
1.1 Revision 1.0.....	1
<b>2 Product Overview.....</b>	<b>2</b>
2.1 Features.....	3
2.2 Benefits.....	3
2.3 Applications.....	3
<b>3 Electrical Specifications.....</b>	<b>4</b>
3.1 SiC MOSFET Characteristics (Per MOSFET).....	4
3.2 SiC Schottky Diode Ratings and Characteristics.....	6
3.3 Thermal and Package Characteristics.....	6
3.4 Typical SiC MOSFET Performance Curves.....	8
3.5 Typical SiC Diode Performance Curves.....	11
<b>4 Package Specifications.....</b>	<b>12</b>
4.1 Package Outline Drawing.....	12

# 1 Revision History

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The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

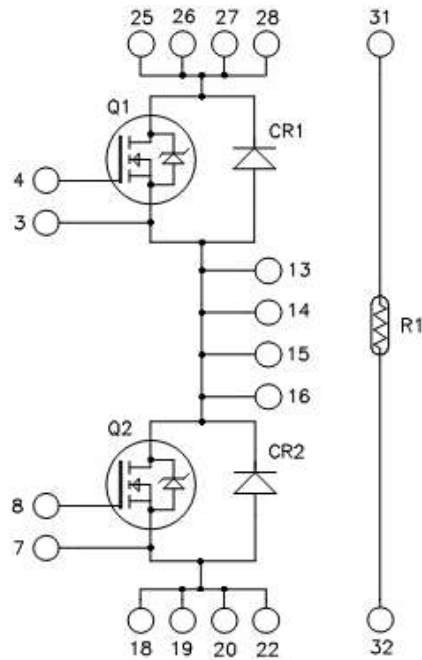
## 1.1 Revision 1.0

Revision 1.0 was published in April 2020. It is the first publication of this document.

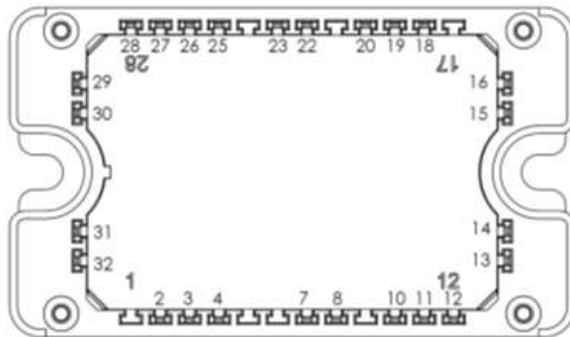
## 2 Product Overview

The MSCSM70AM10CT3AG device is a phase leg 700 V/241 A full silicon carbide (SiC) power module.

**Figure 1 • MSCSM70AM10CT3AG Electric Schematic**



**Figure 2 • MSCSM70AM10CT3AG Pinout Location**



Pins 25 to 28 must be shorted together  
 Pins 13 to 16 must be shorted together  
 Pins 18/19/20/22 must be shorted together

All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified.

**Caution:** These devices are sensitive to electrostatic discharge. Proper handling procedures should be followed.

## 2.1 Features

The following are key features of the MSCSM70AM10CT3AG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High-speed switching
  - Ultra low loss
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF
- Very low stray inductance
- Kelvin source for easy drive
- Internal thermistor for temperature monitoring
- Aluminum nitride (AlN) substrate for improved thermal performance

## 2.2 Benefits

The following are benefits of the MSCSM70AM10CT3AG device:

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

## 2.3 Applications

The MSCSM70AM10CT3AG device is designed for the following applications:

- Uninterruptible power supplies
- Switched mode power supplies
- EV motor and traction drive
- Welding converters

## 3 Electrical Specifications

This section shows the electrical specifications of the MSCSM70AM10CT3AG device.

### 3.1 SiC MOSFET Characteristics (Per MOSFET)

The following table shows the absolute maximum ratings per SiC MOSFET of the MSCSM70AM10CT3AG device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameter	Max 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	-10/25	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 the SiC MOSFET device, but output current must be limited due to size of power connectors.

The following table shows the electrical characteristics per SiC MOSFET of the MSCSM70AM10CT3AG device.

**Table 2 • Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 700\text{ V}$			200	$\mu\text{A}$
$R_{DS(on)}$	Drain-source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 80\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	7.5	9.5	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	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	$V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$			200	nA

The following table shows the dynamic characteristics per SiC MOSFET of the MSCSM70AM10CT3AG device.

**Table 3 • Dynamic Characteristics**

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

The following table shows the body diode ratings and characteristics per SiC MOSFET of the MSCSM70AM10CT3AG device.

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

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

### 3.2 SiC Schottky Diode Ratings and Characteristics

The following table shows the SiC Schottky diode ratings and characteristics of the MSCSM70AM10CT3AG device.

**Table 5 • SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)**

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
$V_{RRM}$	Peak repetitive reverse voltage					700	V
$I_{RM}$	Reverse leakage current	$V_R = 700\text{ V}$	$T_J = 25\text{ °C}$	30	400		$\mu\text{A}$
			$T_J = 175\text{ °C}$		500		
$I_F$	DC forward current				100		A
$V_F$	Diode forward voltage	$I_F = 100\text{ A}$	$T_J = 25\text{ °C}$	1.5	1.8		V
			$T_J = 175\text{ °C}$		1.9		
QC	Total capacitive charge	$V_R = 400\text{ V}$			266		nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 200\text{ V}$			496		$\mu\text{F}$
		$f = 1\text{ MHz}, V_R = 400\text{ V}$			432		
$R_{thJC}$	Junction-to-case thermal resistance					0.456	$^{\circ}\text{C}/\text{W}$

### 3.3 Thermal and Package Characteristics

The following table shows the package characteristics of the MSCSM70AM10CT3AG device.

**Table 6 • Thermal and Package Characteristics**

Symbol	Characteristic			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	2	3	N.m
Wt	Package weight				110	g



The following table shows the temperature sensor NTC (see application note [APT0406](#) on [www.microsemi.com](http://www.microsemi.com)) of the MSCSM70AM07CT3AG device.

**Table 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			4		%
	T <sub>C</sub> = 100 °C				

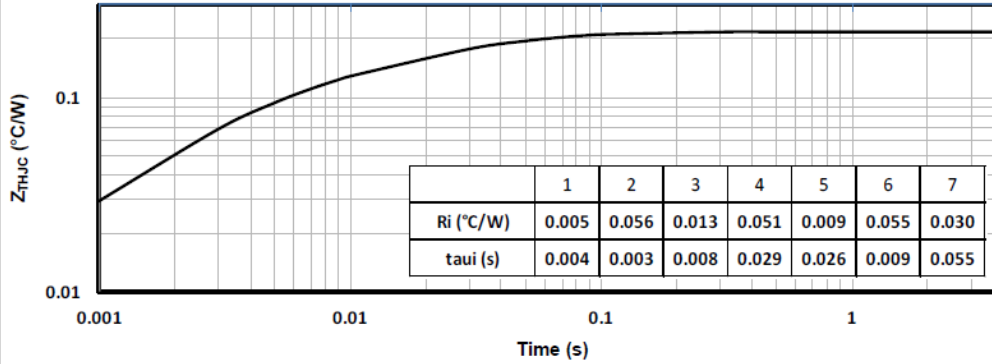
$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

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

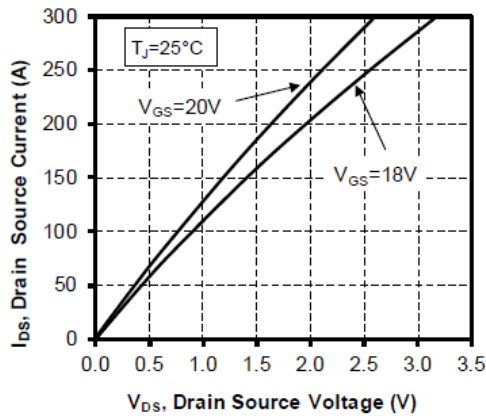
### 3.4 Typical SiC MOSFET Performance Curves

This sections shows the typical SiC MOSFET performance curves of the MSCSM70AM10CT3AG device.

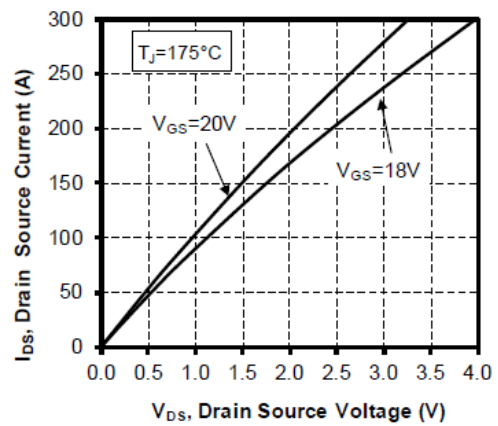
**Figure 3 • Maximum Thermal Impedance**



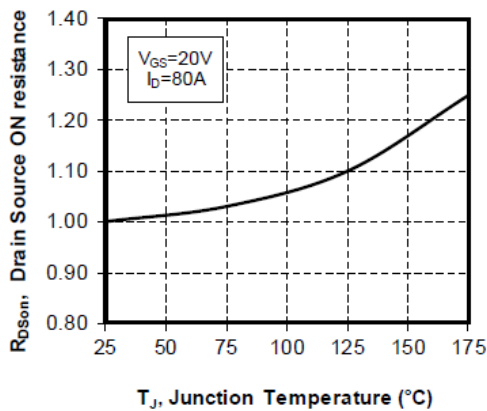
**Figure 4 • Output Characteristics, T<sub>J</sub> = 25 °C**



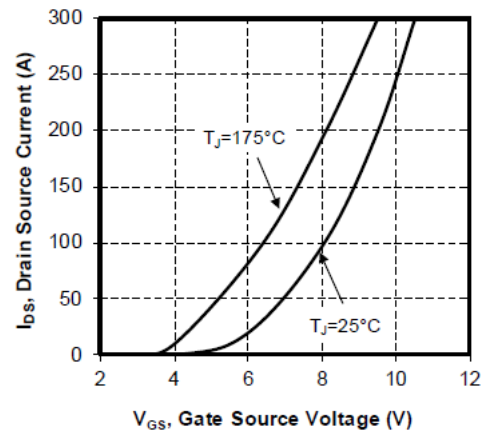
**Figure 5 • Output Characteristics, T<sub>J</sub> = 175 °C**



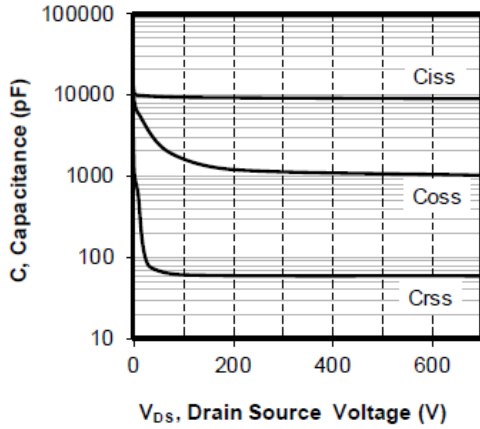
**Figure 6 • Normalized R<sub>DS(on)</sub> vs. Temperature**



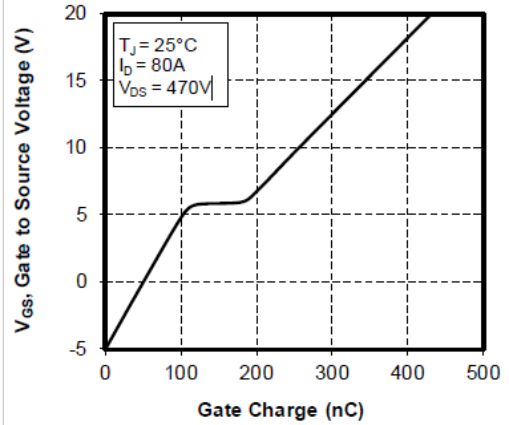
**Figure 7 • Transfer Characteristics**



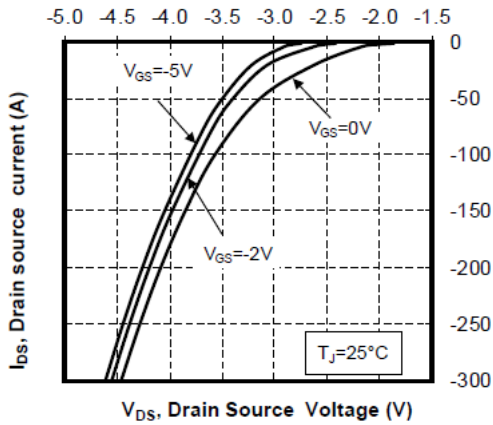
**Figure 8 • Capacitance vs. Drain Source Voltage**



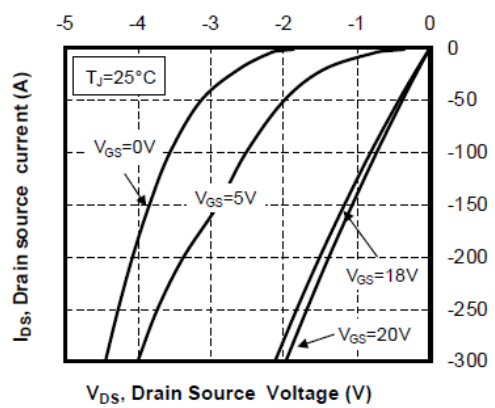
**Figure 9 • Gate Charge vs. Gate Source Voltage**



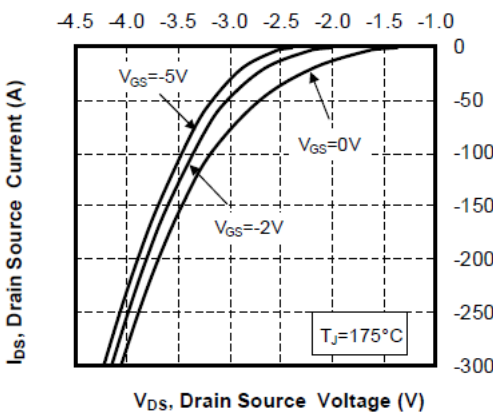
**Figure 10 • Body Diode Characteristics,  $T_J = 25^\circ\text{C}$**



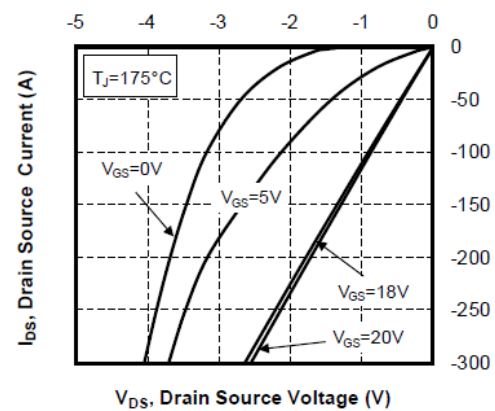
**Figure 11 • 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$**



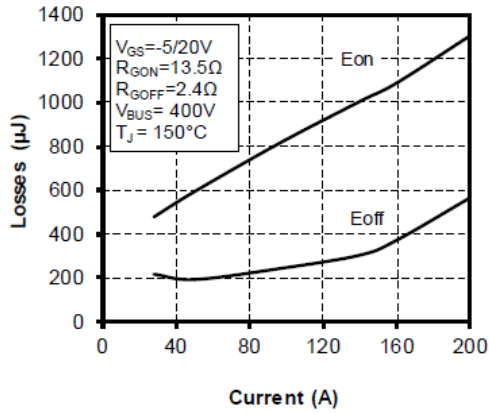
**Figure 12 • Body Diode Characteristics,  $T_J = 175^\circ\text{C}$**



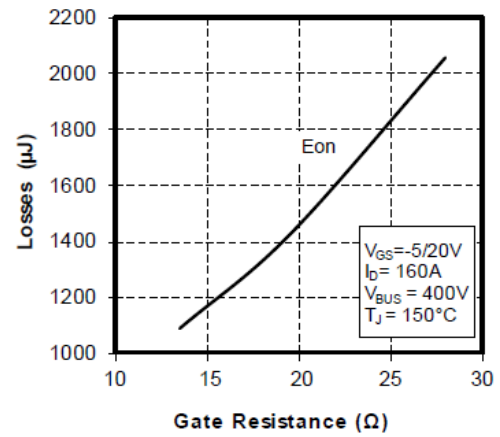
**Figure 13 • 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$**



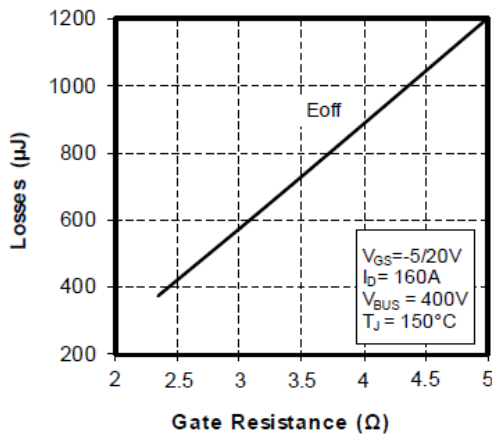
**Figure 14 • Switching Energy vs. Current**



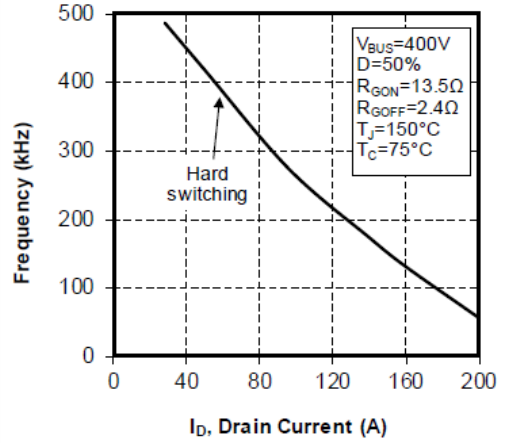
**Figure 15 • Turn On Energy vs. Rg**



**Figure 16 • Turn Off Energy vs. Rg**



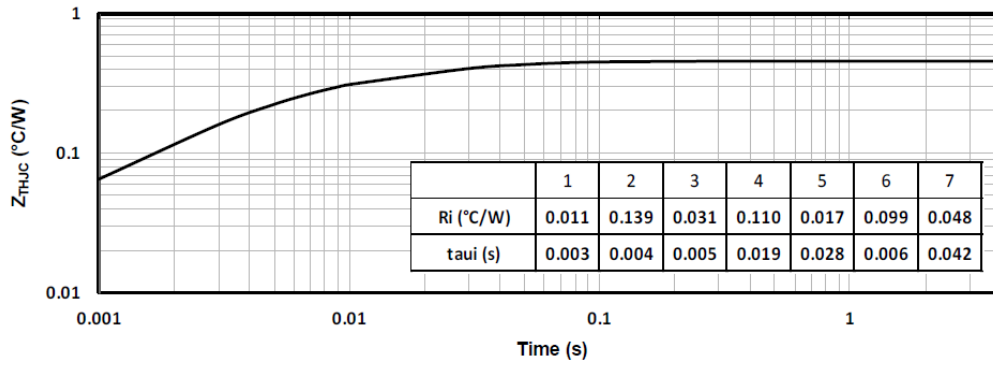
**Figure 17 • Operating Frequency vs Drain Current**



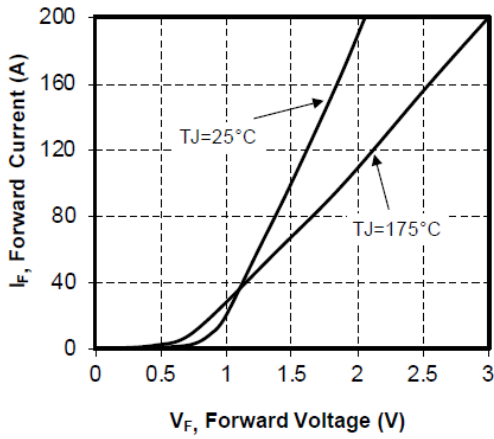
### 3.5 Typical SiC Diode Performance Curves

This sections shows the typical SiC diode performance curves of the MSCSM70AM10CT3AG device.

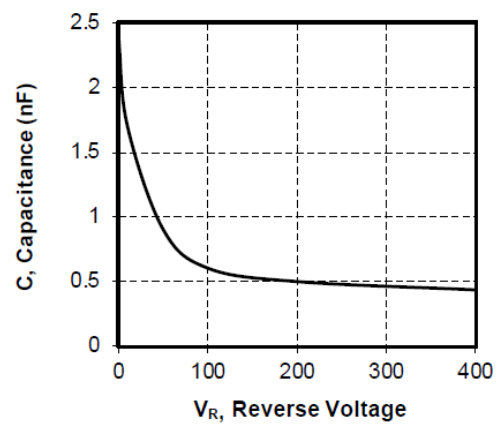
**Figure 18 • Maximum Thermal Impedance**



**Figure 19 • Forward Characteristics**



**Figure 20 • Capacitance vs. Reverse Voltage**



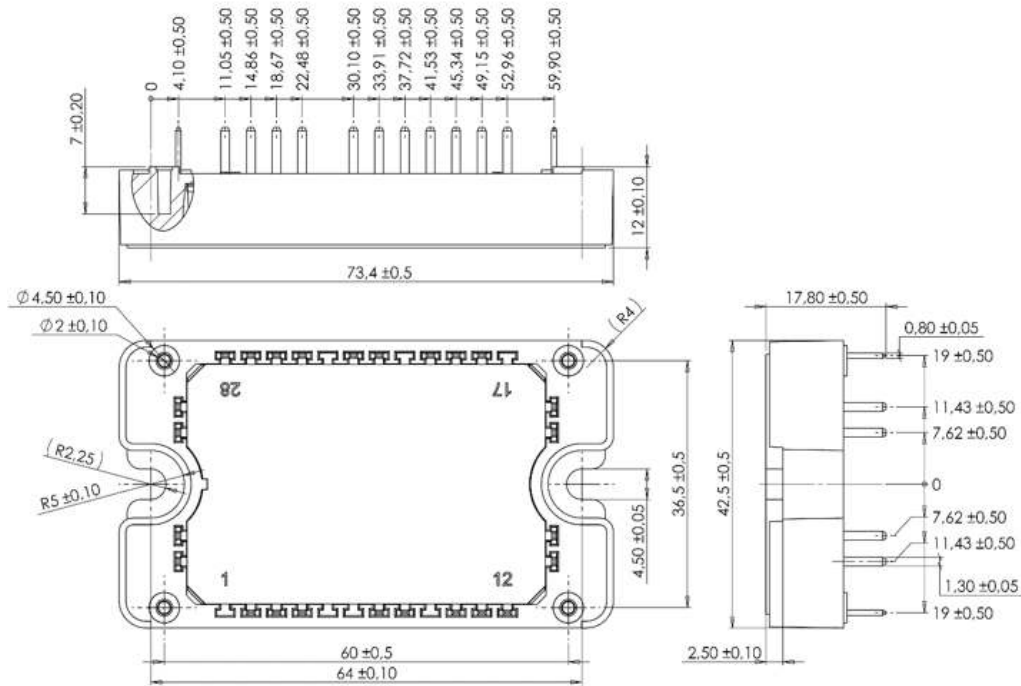
## 4 Package Specifications

This section shows the package specification of the MSCSM70AM10CT3AG device.

### 4.1 Package Outline Drawing

This section shows the package outline drawing of the MSCSM70AM10CT3AG device. The dimensions in the following figure are in millimeters.

Figure 21 • Package Outline Drawing



**Note:** See application note [1906—Mounting Instructions for SP3F Power Modules](#) at [www.microsemi.com](http://www.microsemi.com).

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