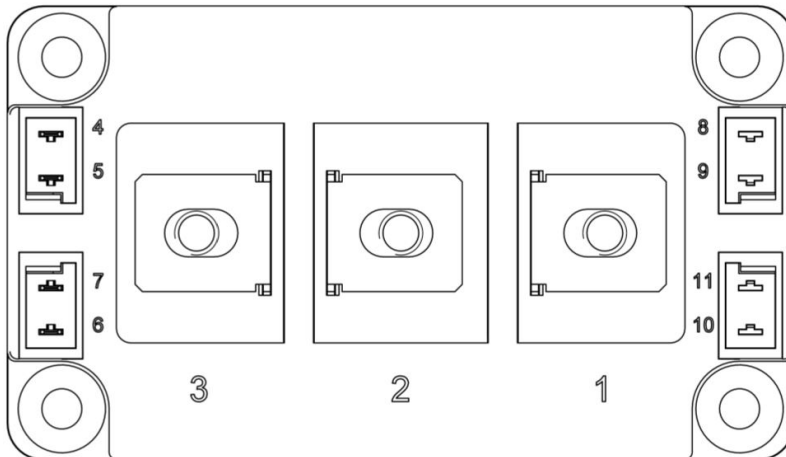
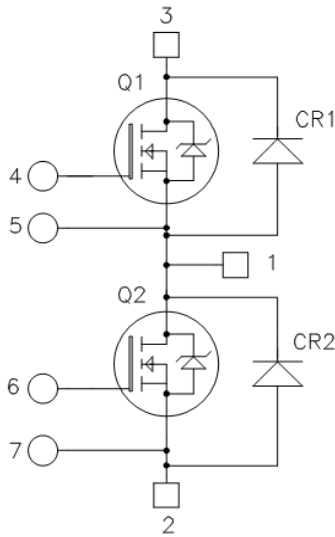


## Phase Leg SiC Power Module

### Product Overview

The MSCSM170AM058CD3AG device is a 1700 V/353 A phase leg silicon carbide (SiC) power module.



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

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

## Features

The following are the key features of MSCSM170AM058CD3AG 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
- Kelvin emitter for easy drive
- High level of integration
- M6 power connectors
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM170AM058CD3AG device:

- High efficiency converter
- Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS Compliant

## Applications

The following are the applications of MSCSM170AM058CD3AG device:

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

### 1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM170AM058CD3AG device.

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

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM170AM058CD3AG device.

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

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	353
		$T_C = 80\text{ }^\circ\text{C}$	281
$I_{DM}$	Pulsed drain current	700	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	7.5	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	1642

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM170AM058CD3AG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}; V_{DS} = 1700\text{ V}$	—	60	600	$\mu\text{A}$	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 180\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	5.8	7.5	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	10.2	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}; I_D = 15\text{ mA}$	1.8	3.3	—	V	
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{ V}; V_{DS} = 0\text{ V}$	—	—	600	nA	

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM170AM058CD3AG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	—	19.8	—	nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$	—	0.9	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.06	—	
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$	—	1068	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 850\text{ V}$	—	294	—	
$Q_{gd}$	Gate-drain charge	$I_D = 180\text{ A}$	—	162	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5\text{ V}/20\text{ V}$	—	75	—	ns
$T_r$	Rise time	$V_{Bus} = 900\text{ V}$	—	75	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 300\text{ A}$	—	153	—	
$T_f$	Fall time	$T_J = 150\text{ °C}$ $R_{GON} = 4.7\ \Omega$ $R_{GOFF} = 2.7\ \Omega$	—	56	—	
$E_{on}$	Turn-on energy	$V_{GS} = -5\text{ V}/20\text{ V}$	—	13.5	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 900\text{ V}$ $I_D = 300\text{ A}$ $R_{GON} = 4.7\ \Omega$ $R_{GOFF} = 2.7\ \Omega$				
$R_{Gint}$	Internal gate resistance		—	0.98	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.09	$^{\circ}\text{C}/\text{W}$

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM170AM058CD3AG device.

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

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}; I_{SD} = 180\text{ A}$	—	3.7	—	V
		$V_{GS} = -5\text{ V}; I_{SD} = 180\text{ A}$	—	3.9	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 180\text{ A}$	—	27	—	ns
$Q_{rr}$	Reverse recovery charge	$V_{GS} = -5\text{ V}$	—	3.9	—	$\mu\text{C}$
$I_{rr}$	Reverse recovery current	$V_R = 900\text{ V}$ $di_F/dt = 6000\text{ A}/\mu\text{s}$	—	276	—	A

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

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM170AM058CD3AG device.

**Table 1-5. SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$V_{RRM}$	Peak repetitive reverse voltage		—	—	1700	V	
$I_{RRM}$	Reverse leakage current	$V_R = 1700\text{ V}$	$T_J = 25\text{ °C}$	—	60	1200	$\mu\text{A}$
			$T_J = 175\text{ °C}$	—	900	—	
$I_F$	Forward current						
$V_F$	Diode forward voltage	$I_F = 180\text{ A}$	$T_J = 25\text{ °C}$	—	1.5	1.8	V
			$T_J = 175\text{ °C}$	—	2.3	—	
$Q_C$	Total capacitive charge	$V_R = 900\text{ V}$	—	1380	—	nC	
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600\text{ V}$	—	1002	—	$\mu\text{F}$	
		$f = 1\text{ MHz}, V_R = 900\text{ V}$	—	828	—		
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.1	$^{\circ}\text{C/W}$	

### 1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM170AM058CD3AG device.

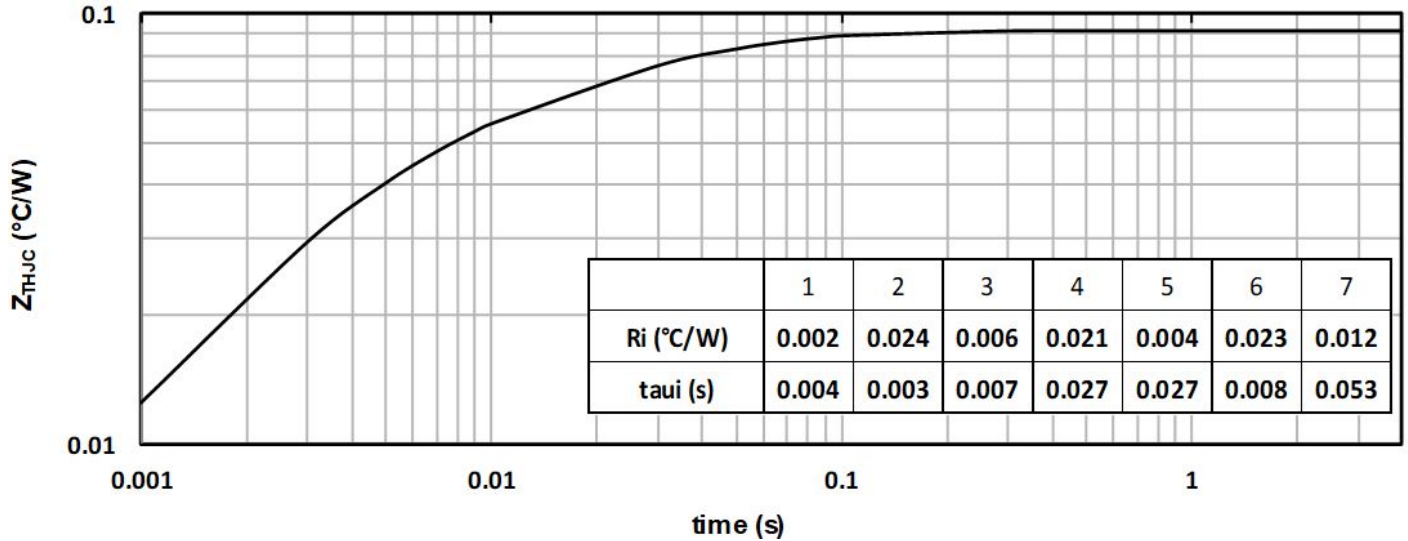
**Table 1-6. Thermal and Package Characteristics**

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 case temperature	−40	125			
$T_C$	Operating case temperature	−40	125			
Torque	Mounting torque	For terminals	M6		3	5
		To heatsink	M6	3	5	
Wt	Package weight	—	350	g		

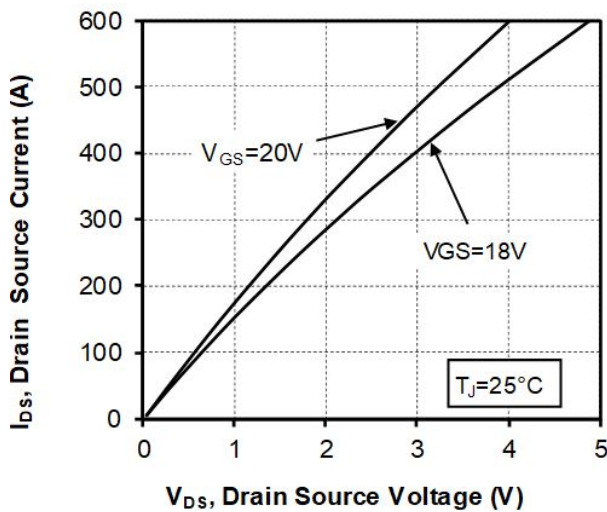
### 1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM170AM058CD3AG device.

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



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



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

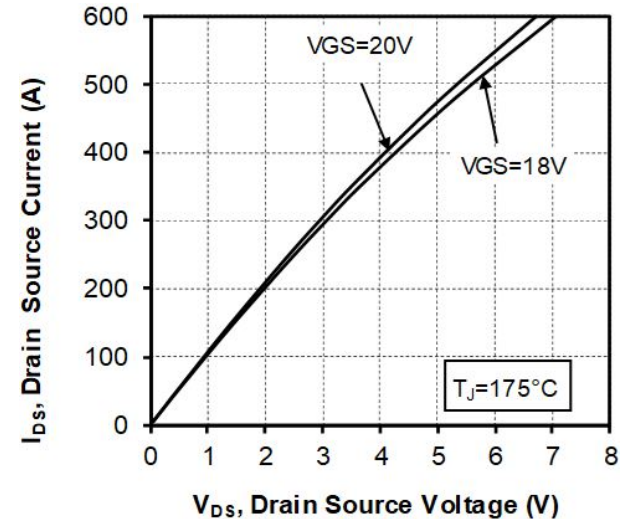


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

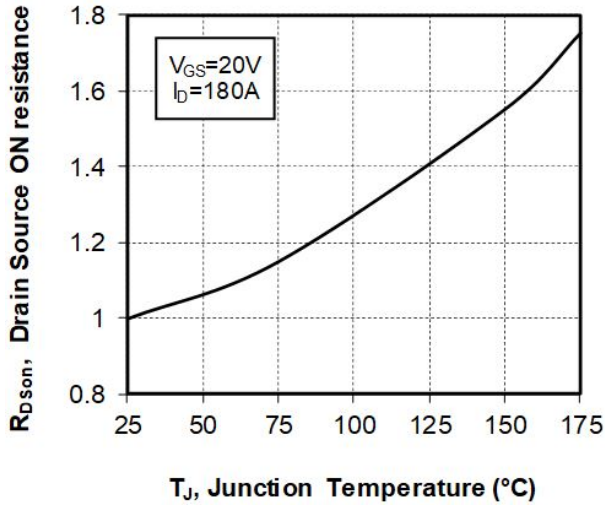


Figure 1-5. Transfer Characteristics

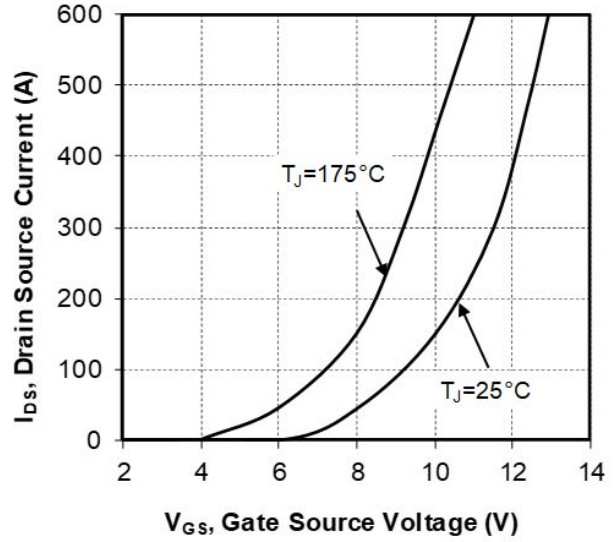


Figure 1-6. Switching Energy vs.  $R_g$

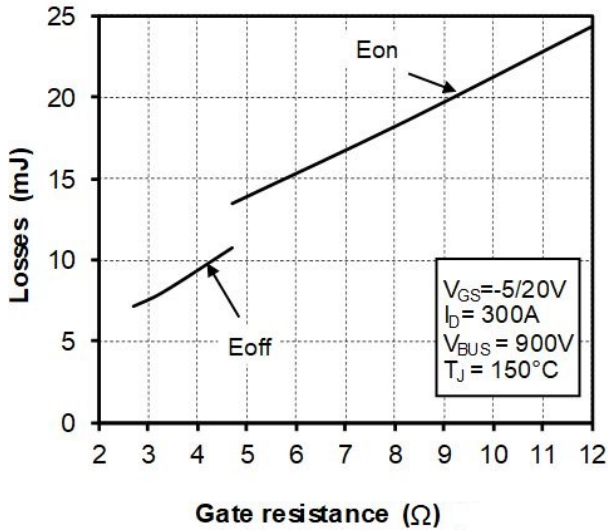


Figure 1-7. Switching Energy vs. Current

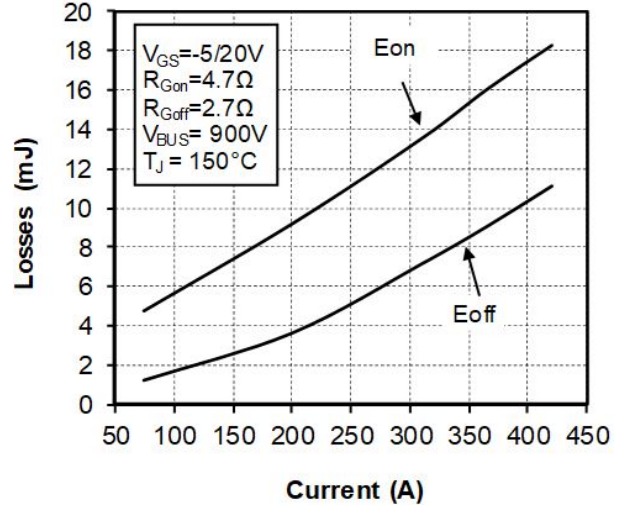




Figure 1-8. Capacitance vs. Drain Source Voltage

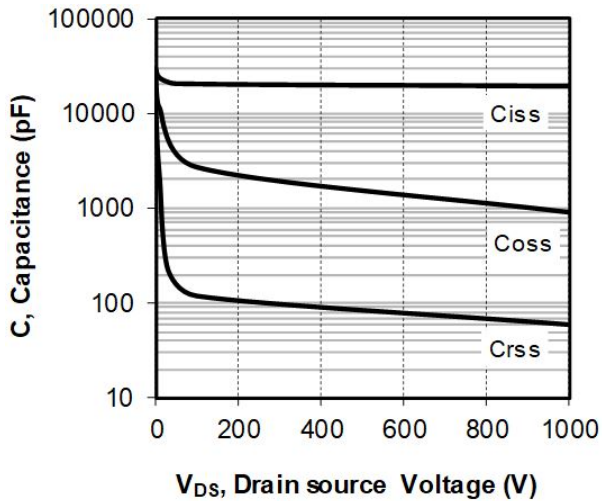


Figure 1-9. Gate Charge vs. Gate Source Voltage

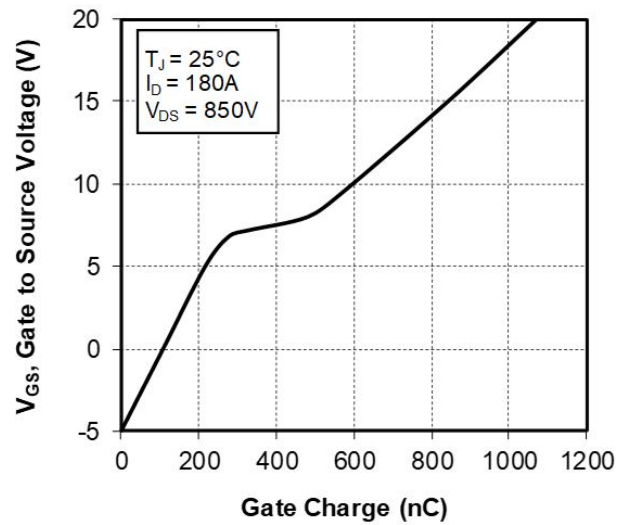


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

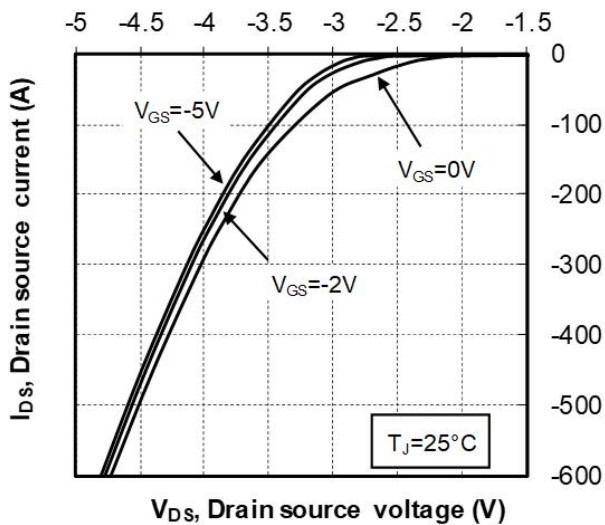


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

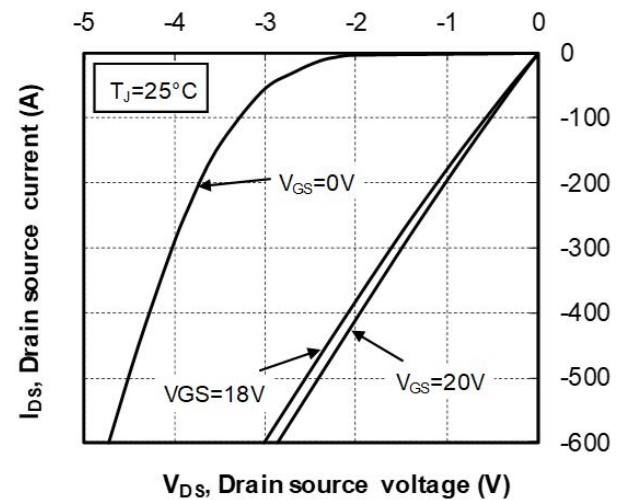


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

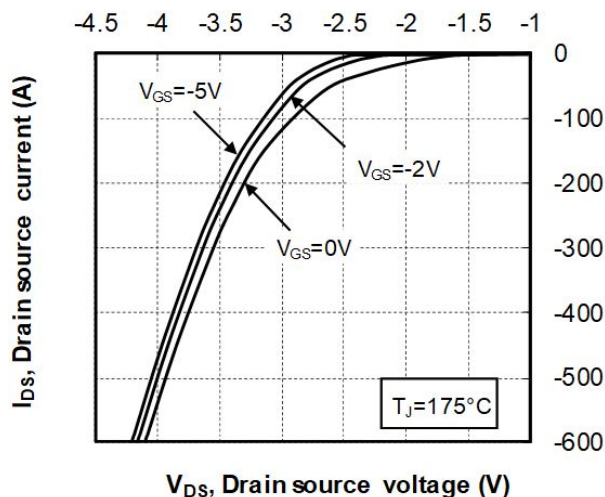
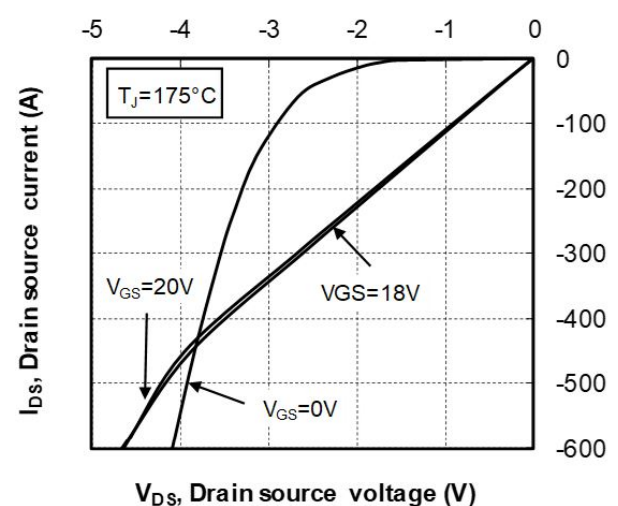
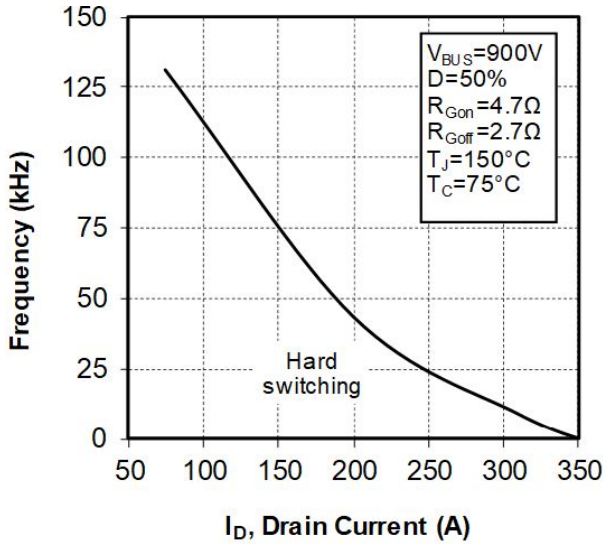


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$





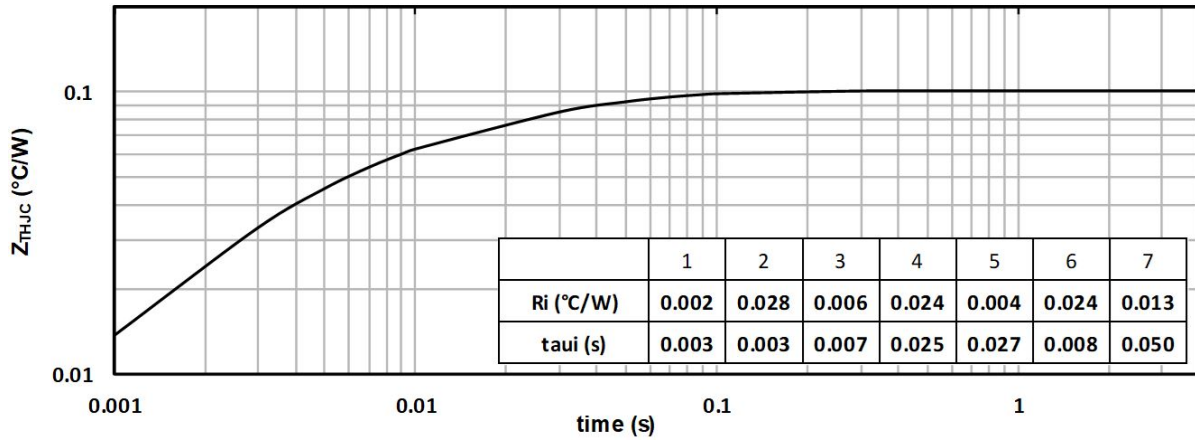
**Figure 1-14. Operating Frequency vs. Drain Current**



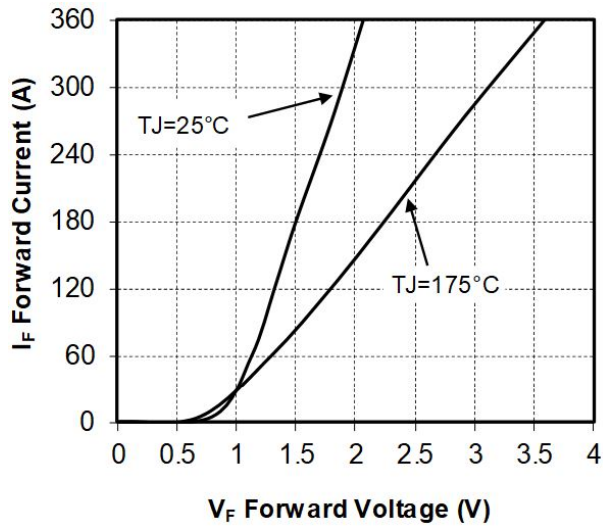
## 1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM170AM058CD3AG device.

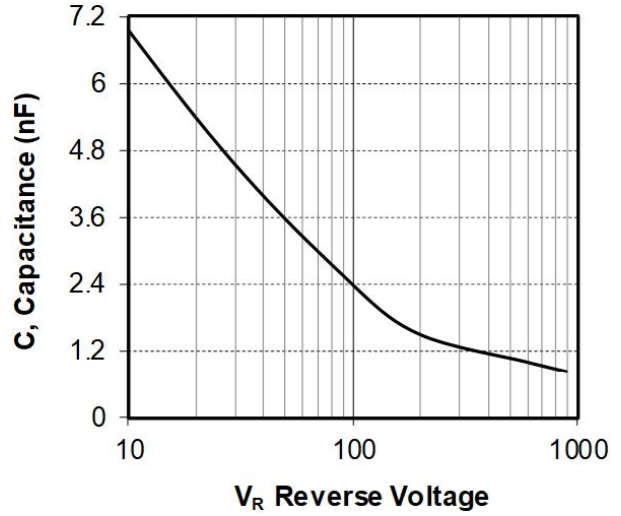
**Figure 1-15. Maximum Thermal Impedance**



**Figure 1-16. Forward Characteristics**



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





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Revision	Date	Description
A	04/2021	This is the first publication of this document.

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