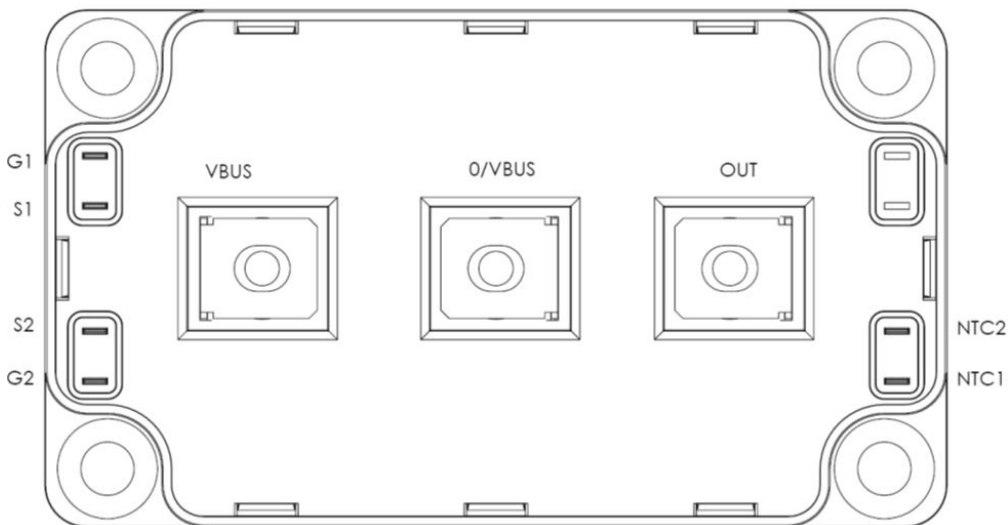
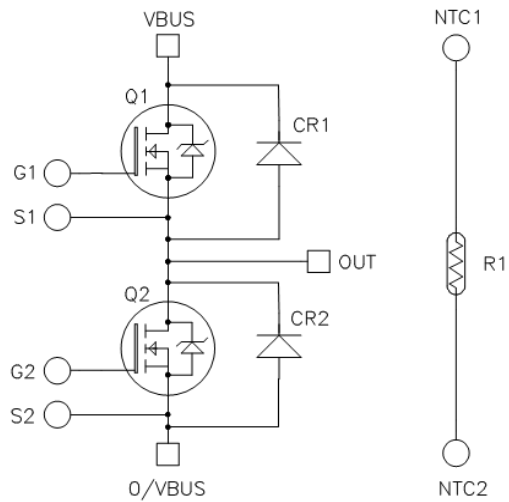


## Phase Leg SiC Power Module

### Product Overview

The MSCSM170AM058CT6AG 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 MSCSM170AM058CT6AG 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 source for easy drive
- Low stray inductance
- M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM170AM058CT6AG 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 MSCSM170AM058CT6AG 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 MSCSM170AM058CT6AG device.

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

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM170AM058CT6AG device.

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

Symbol	Parameter		Maximum Ratings	Unit
$V_{DS}$	Drain-Source voltage		1700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	353	A
		$T_C = 80\text{ }^{\circ}\text{C}$	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	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM170AM058CT6AG 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 MSCSM170AM058CT6AG 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	$T_J = 150\text{ °C}$ $R_{GON} = 4.7\text{ }\Omega$ $R_{GOFF} = 2.7\text{ }\Omega$	—	56	—	
$E_{on}$	Turn-on energy	$V_{GS} = -5\text{ V}/20\text{ V}$	$T_J = 150\text{ °C}$	—	13.5	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 900\text{ V}$ $I_D = 300\text{ A}$ $R_{GON} = 4.7\text{ }\Omega$ $R_{GOFF} = 2.7\text{ }\Omega$	$T_J = 150\text{ °C}$	—	7.2	
$R_{Gint}$	Internal gate resistance		—	0.98	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.09	$^{\circ}\text{C/W}$

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM170AM058CT6AG 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 MSCSM170AM058CT6AG 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	$T_C = 125\text{ °C}$		—	180	—	A
$V_F$	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	—	pF
		$f = 1\text{ MHz}, V_R = 900\text{ V}$		—	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 MSCSM170AM058CT6AG 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	To heatsink	M6	3	5	N.m
		For terminals	M5	2	3.5	
Wt	Package weight			—	300	g

The following table lists the temperature sensor NTC of the MSCSM170AM058CT6AG 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	—	%

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

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

The following figures show the SiC MOSFET performance curves of the MSCSM170AM058CT6AG device.

Figure 1-1. Maximum Thermal Impedance

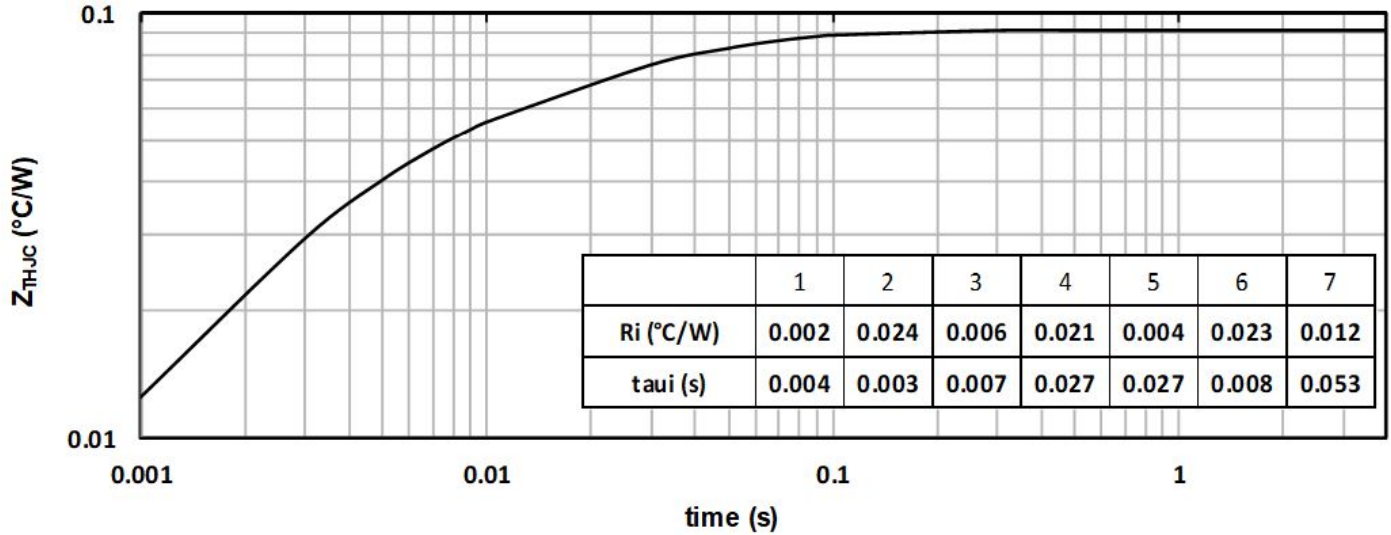


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

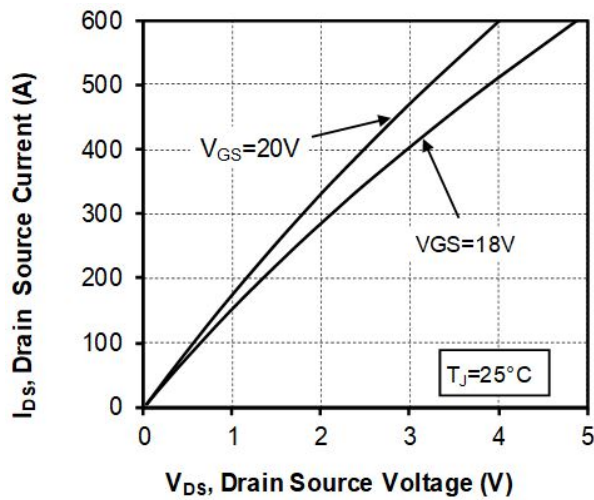


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

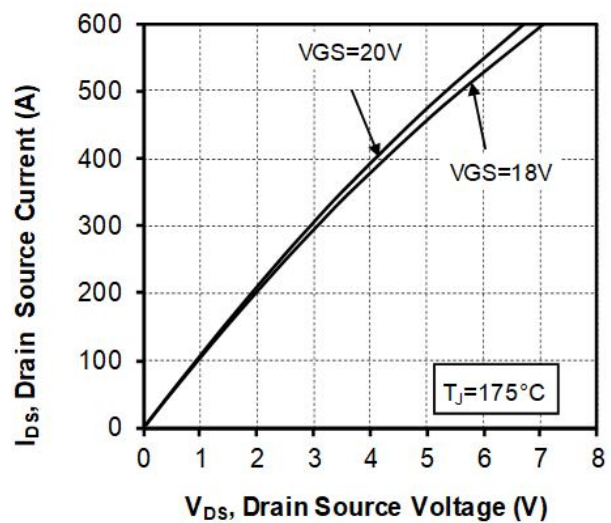


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

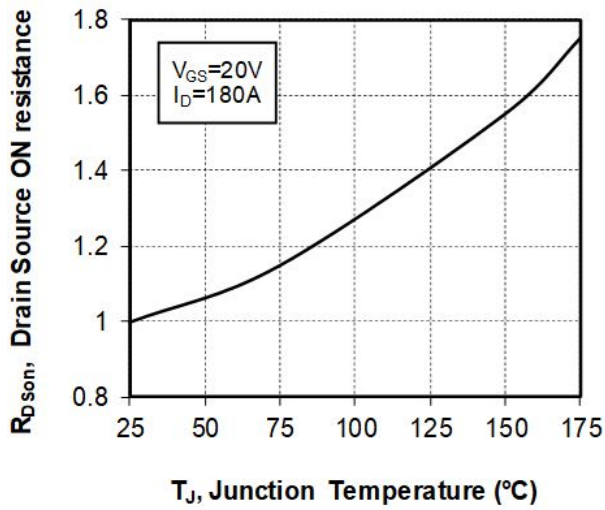


Figure 1-5. Transfer Characteristics

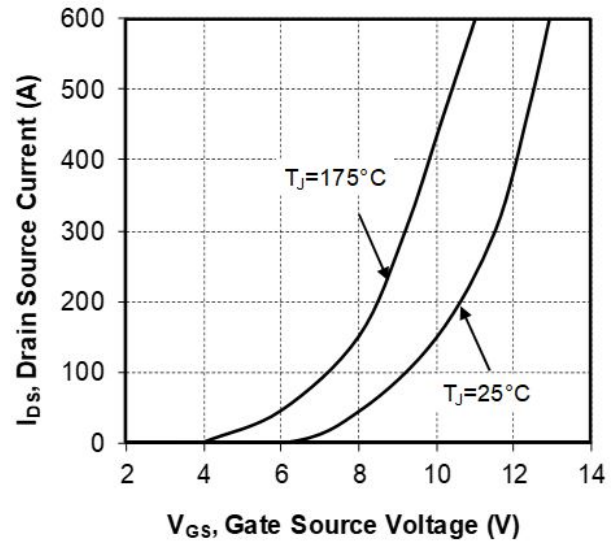


Figure 1-6. Switching Energy vs.  $R_g$

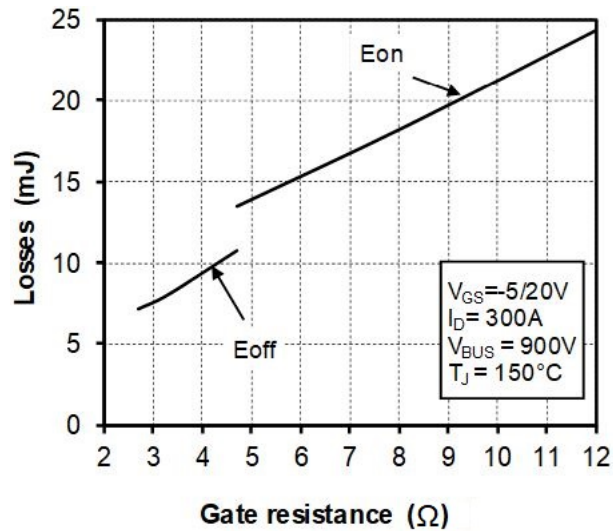


Figure 1-7. Switching Energy vs. Current

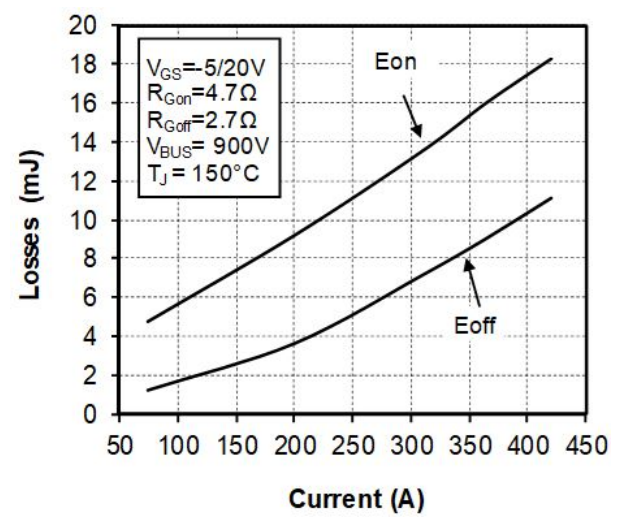




Figure 1-8. Capacitance vs. Drain Source Voltage

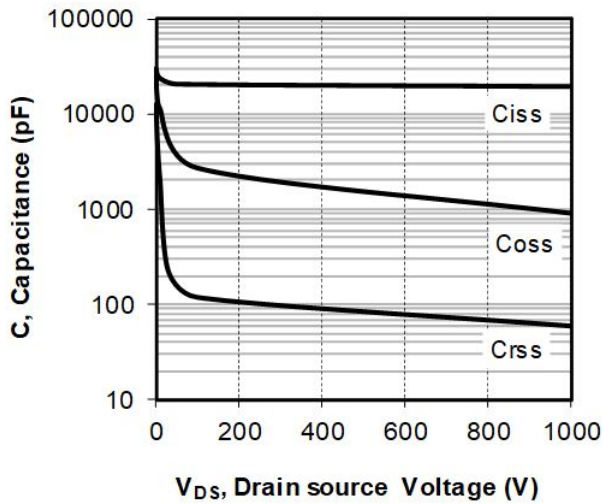


Figure 1-9. Gate Charge vs. Gate Source Voltage

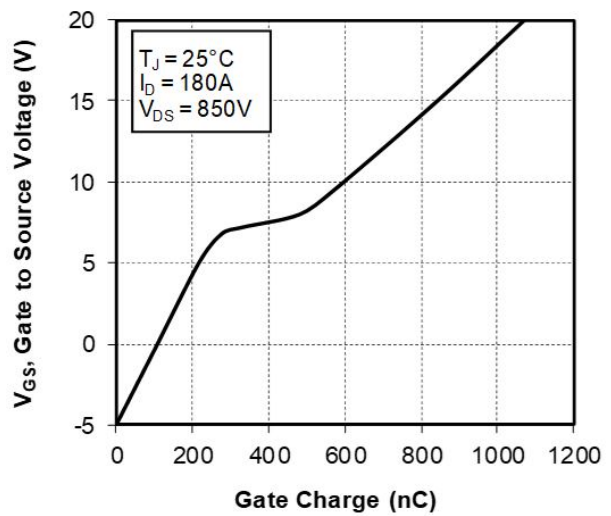


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

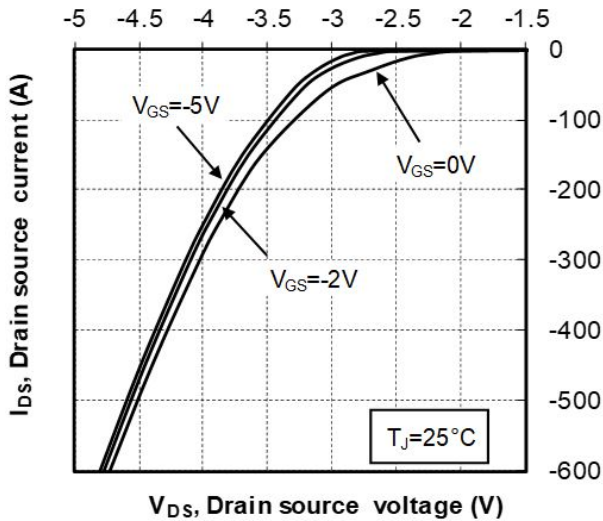


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

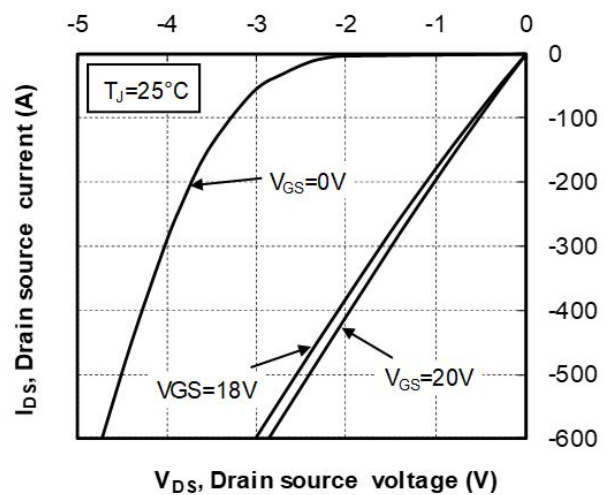


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

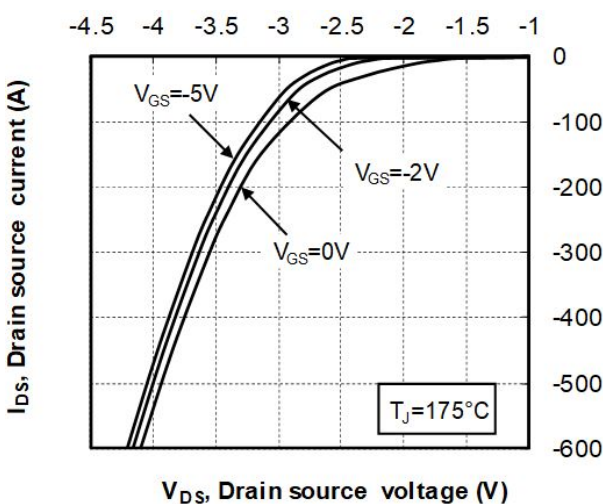


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

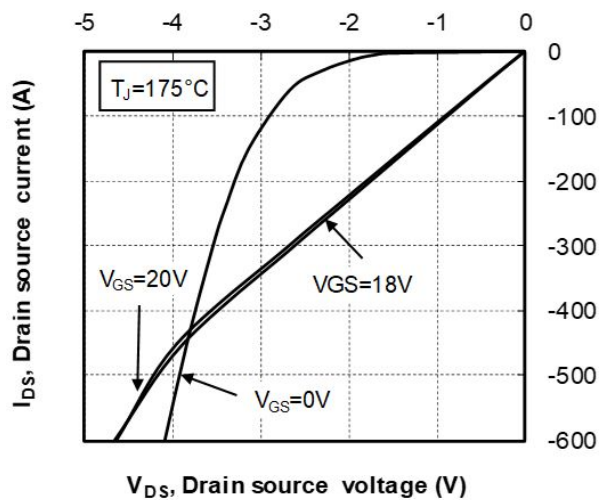
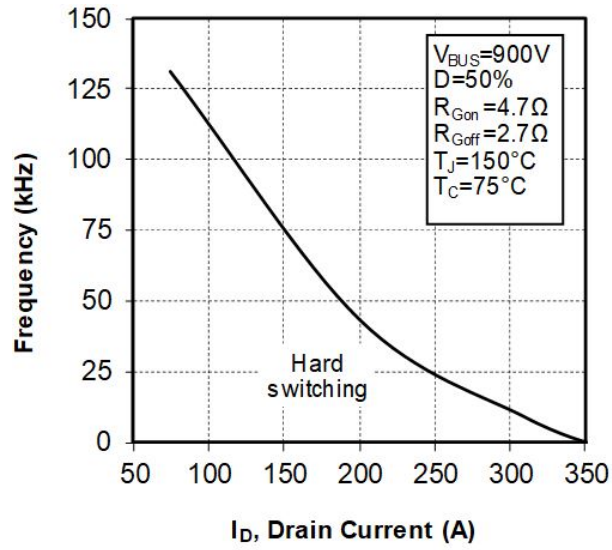


Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM170AM058CT6AG device.

Figure 1-15. Maximum Thermal Impedance

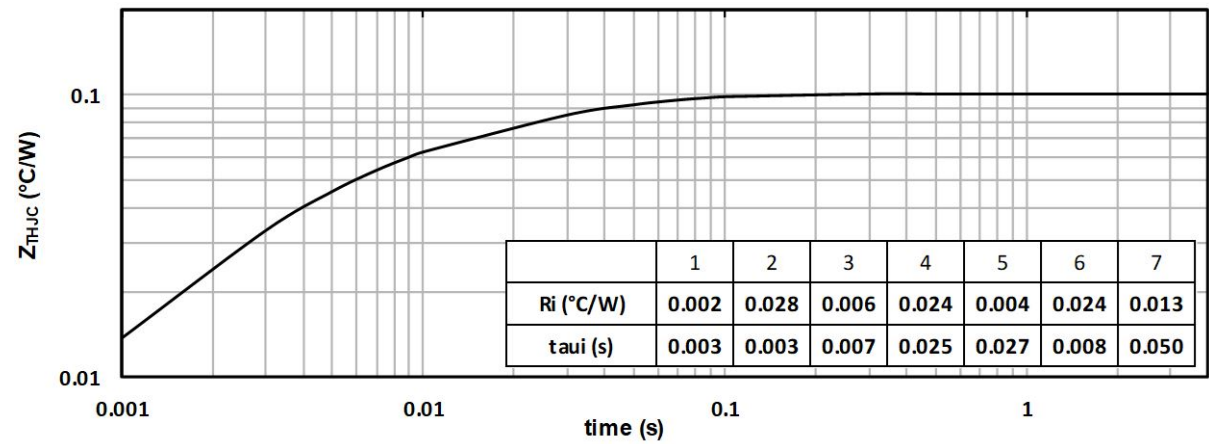


Figure 1-16. Forward Characteristics

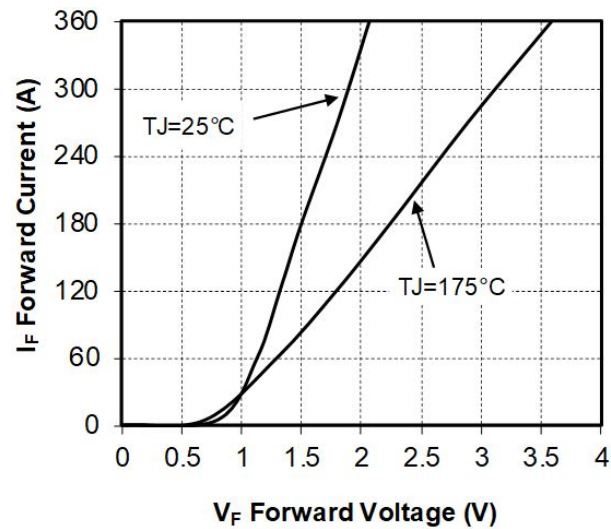
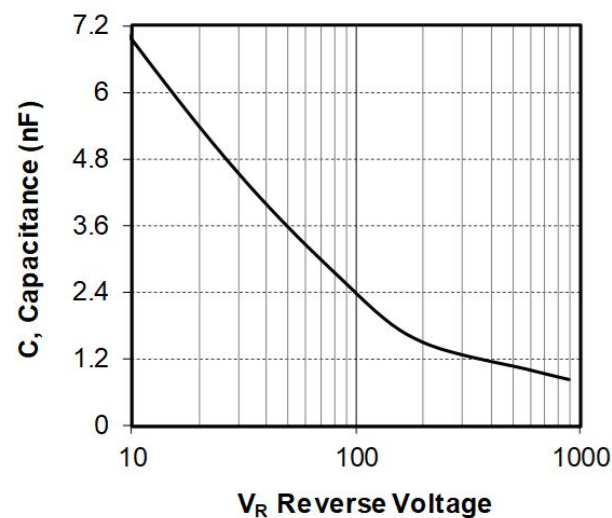


Figure 1-17. Capacitance vs. Reverse Voltage



The following section shows the package specification of the MSCSM170AM058CT6AG device.

The following figure shows the package outline drawing of the MSCSM170AM058CT6AG device. The dimensions in the following figure are in millimeters.

[illegible]

**Note:** See application note [APT0601—Mounting Instructions for SP6 Power Modules](#) for more information.

**3. Revision History**

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

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