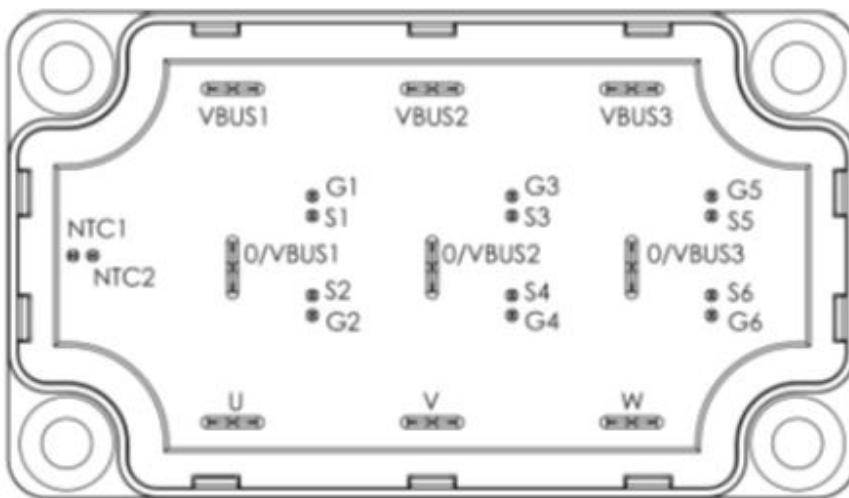
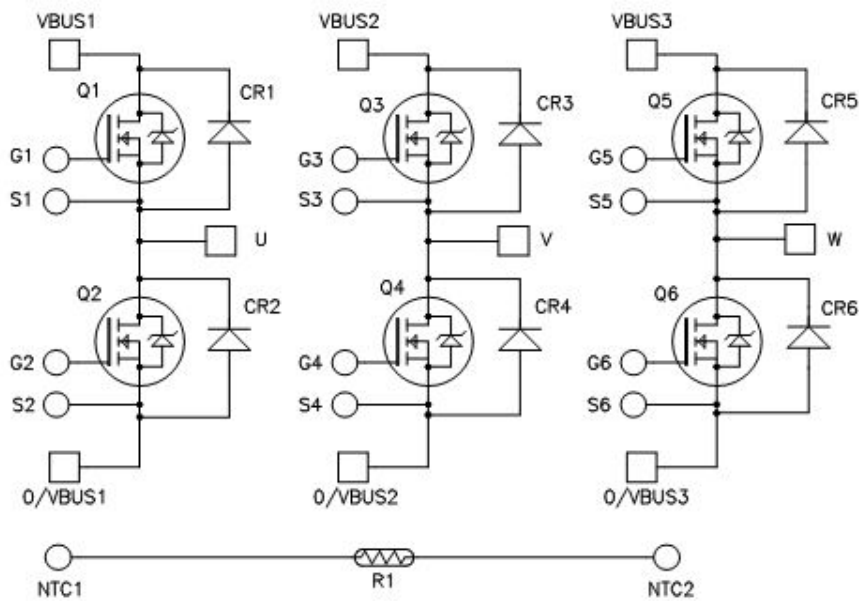


## Triple Phase Leg SiC MOSFET Power Module

### Product Overview

The MSCSM170TAM23CTPAG device is a triple phase leg 1700 V, 122 A silicon carbide (SiC) MOSFET 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

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The following are key features of the MSCSM170TAM23CTPAG 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
- 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 MSCSM170TAM23CTPAG device:

- High power and efficiency converters and inverters
- 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 mounting of PCB
- Low profile
- RoHS compliant

## Application

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The MSCSM170TAM23CTPAG device is designed for the following applications:

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

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM170TAM23CTPAG device.

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

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170TAM23CTPAG device.

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

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	122
		$T_C = 80\text{ }^\circ\text{C}$	97
$I_{DM}$	Pulsed drain current	240	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	22.5	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	588
			W

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170TAM23CTPAG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}; V_{DS} = 1700\text{ V}$	—	20	200	$\mu\text{A}$	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 60\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	17.5	22.5	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	31	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}; I_D = 5\text{ mA}$	1.8	3.2	—	V	
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{ V}; V_{DS} = 0\text{ V}$	—	—	200	nA	

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170TAM23CTPAG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	—	6600	—	pF	
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$	—	300	—		
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	20	—		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$	—	356	—	nC	
$Q_{gs}$	Gate-Source charge	$V_{Bus} = 850\text{ V}$	—	98	—		
$Q_{gd}$	Gate-Drain charge	$I_D = 60\text{ A}$	—	54	—		
$T_{d(on)}$	Turn-on delay time	$T_J = 150\text{ °C}$	—	24	—	ns	
$T_r$	Rise time	$V_{GS} = -5\text{ V}/20\text{ V}$	—	17	—		
$T_{d(off)}$	Turn-off delay time	$V_{Bus} = 900\text{ V}$	—	35	—		
$T_f$	Fall time	$I_D = 100\text{ A}$ $R_{G(on)} = 2.4\ \Omega$ $R_{G(off)} = 1.4\ \Omega$	—	19	—		
$E_{on}$	Turn-on energy	$V_{GS} = -5\text{ V}/20\text{ V}$	$T_J = 150\text{ °C}$	—	2.2	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 900\text{ V}$ $I_D = 100\text{ A}$ $R_{G(on)} = 2.4\ \Omega$ $R_{G(off)} = 1.4\ \Omega$	$T_J = 150\text{ °C}$	—	0.33	—	
$R_{Gint}$	Internal gate resistance		—	2.93	—	$\Omega$	
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.255	$^{\circ}\text{C}/\text{W}$	

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170TAM23CTPAG device.

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

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}; I_{SD} = 60\text{ A}$	—	3.7	—	V
		$V_{GS} = -5\text{ V}; I_{SD} = 60\text{ A}$	—	3.9	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 60\text{ A}; V_{GS} = -5\text{ V}$	—	27	—	ns
$Q_{rr}$	Reverse recovery charge	$V_R = 900\text{ V}; di_F/dt = 2000\text{ A}/\mu\text{s}$	—	1300	—	nC
$I_{rr}$	Reverse recovery current		—	92	—	A

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

The following table lists the SiC diode ratings and characteristics per SiC diode of MSCSM170TAM23CTPAG device.

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

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
$V_{RRM}$	Peak repetitive reverse voltage			—	—	1700	V
$I_{RRM}$	Reverse leakage current	$V_R = 1700\text{ V}$	$T_J = 25\text{ °C}$	—	10	200	$\mu\text{A}$
			$T_J = 175\text{ °C}$	—	150	—	
$I_F$	DC forward current	—	$T_C = 125\text{ °C}$	—	30	—	A
$V_F$	Diode forward voltage	$I_F = 30\text{ A}$	$T_J = 25\text{ °C}$	—	1.5	1.8	V
			$T_J = 175\text{ °C}$	—	2.3	—	
$Q_C$	Total capacitive charge	$V_R = 900\text{ V}$		—	230	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600\text{ V}$		—	167	—	pF
		$f = 1\text{ MHz}, V_R = 900\text{ V}$		—	138	—	
$R_{thJC}$	Junction-to-case thermal resistance			—	—	0.532	$^{\circ}\text{C/W}$

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170TAM23CTPAG device.

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

Symbol	Characteristics			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	M6	3	5	N.m
Wt	Package weight			—	250	g

The following table lists the temperature sensor NTC of the MSCSM170TAM23CTPAG 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

This section shows the typical SiC MOSFET performance curves of the MSCSM170TAM23CTPAG device.

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

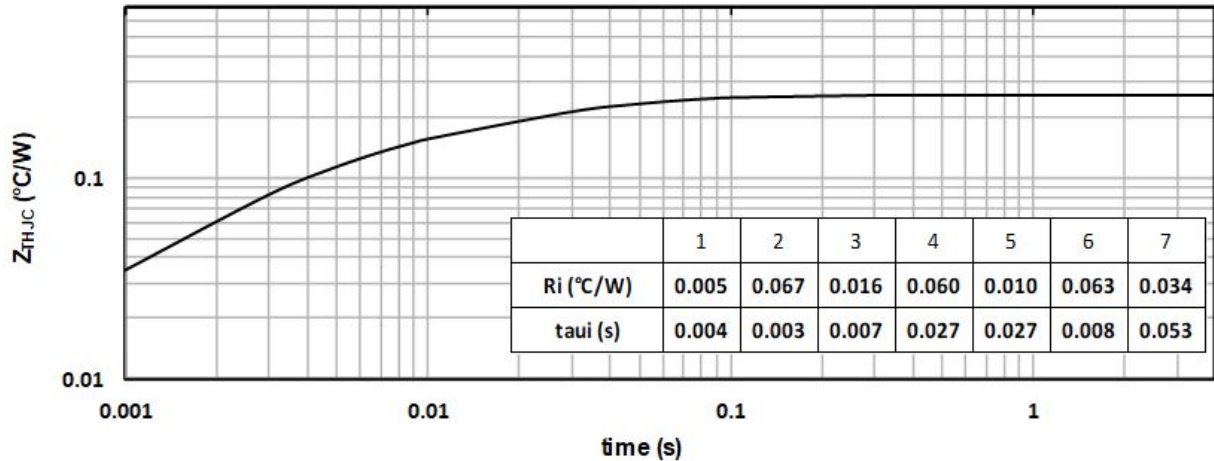


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

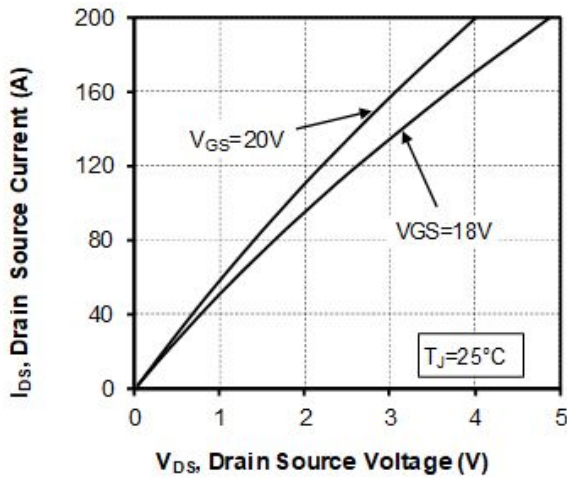


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

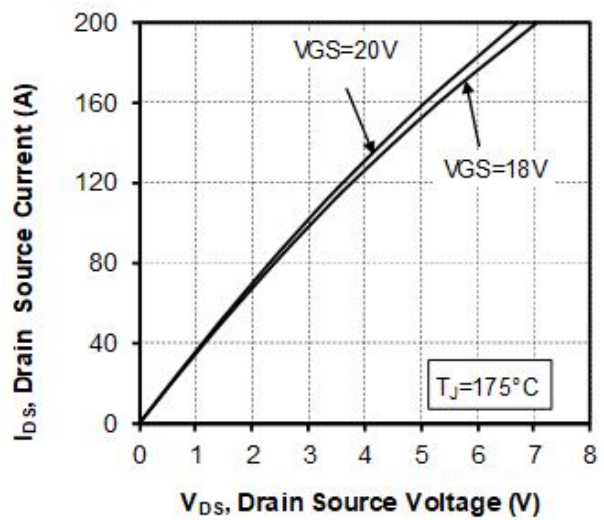


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

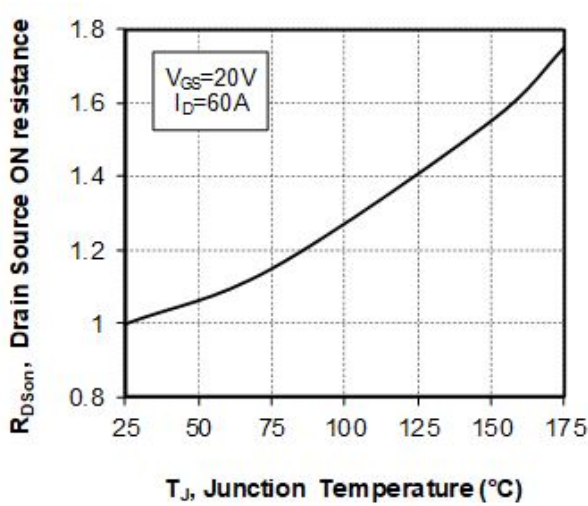
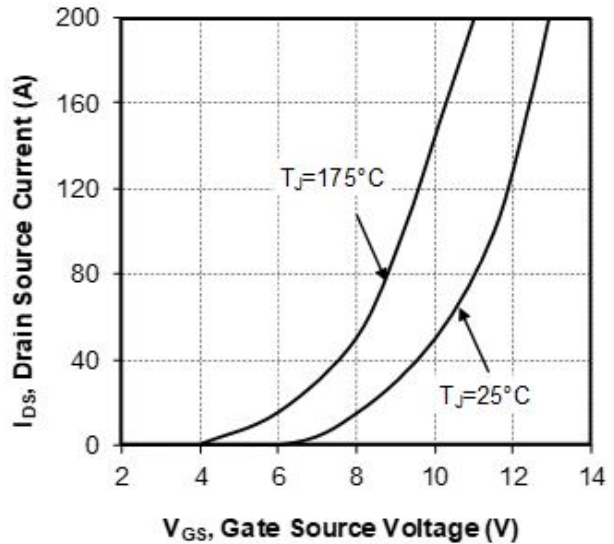
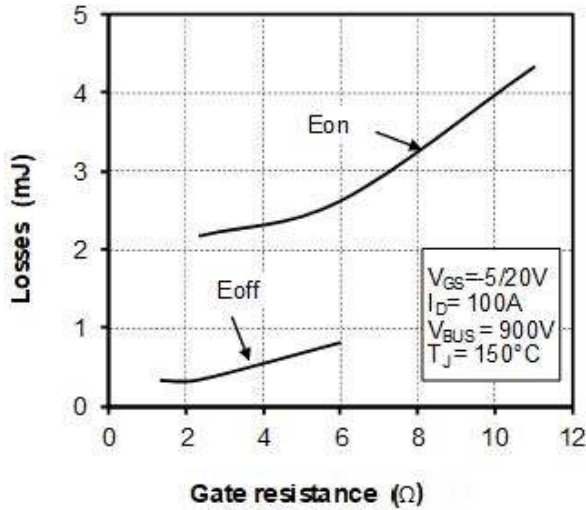


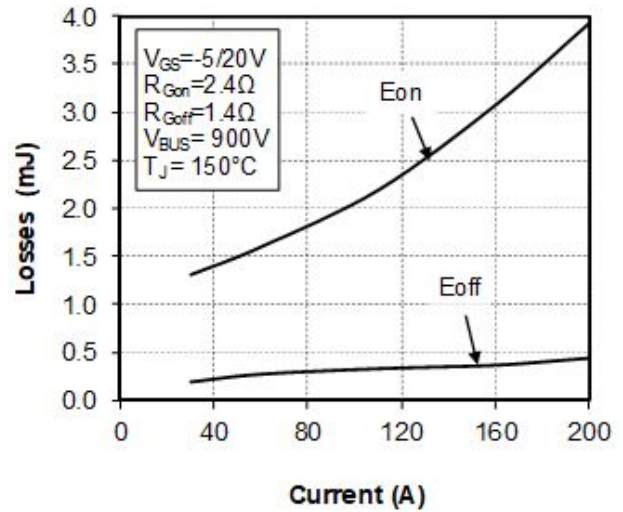
Figure 1-5. Transfer Characteristics



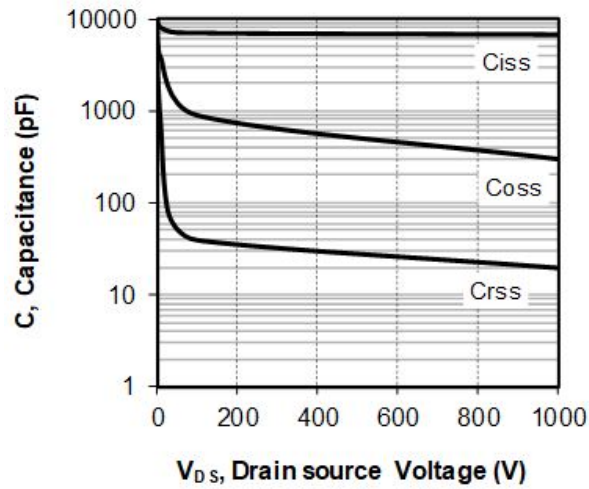
**Figure 1-6. Switching Energy vs. Rg**



**Figure 1-7. Switching Energy vs. Current**



**Figure 1-8. Capacitance vs. Drain Source Voltage**



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

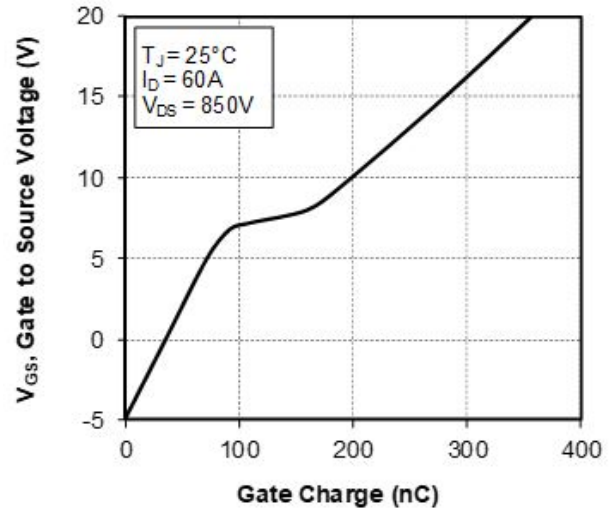




Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

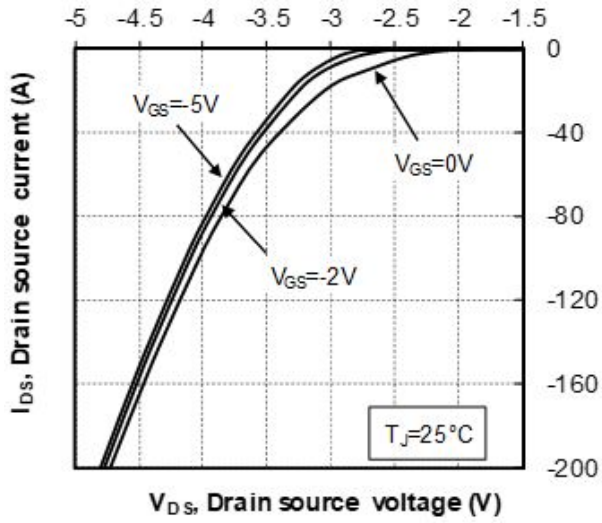


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

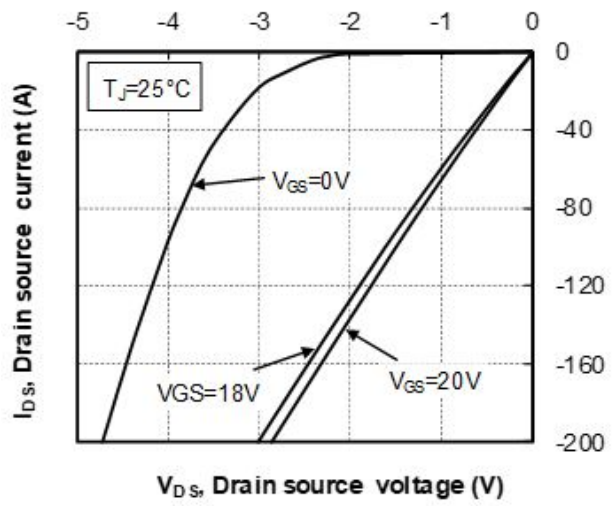


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

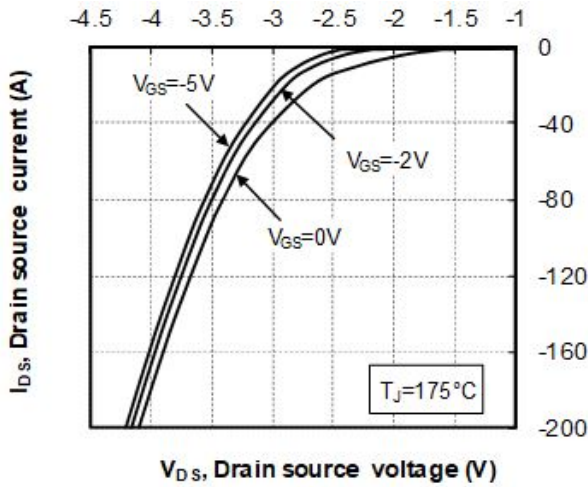
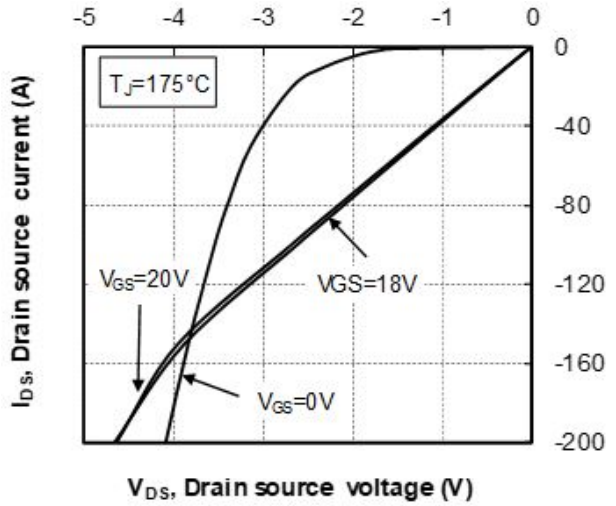
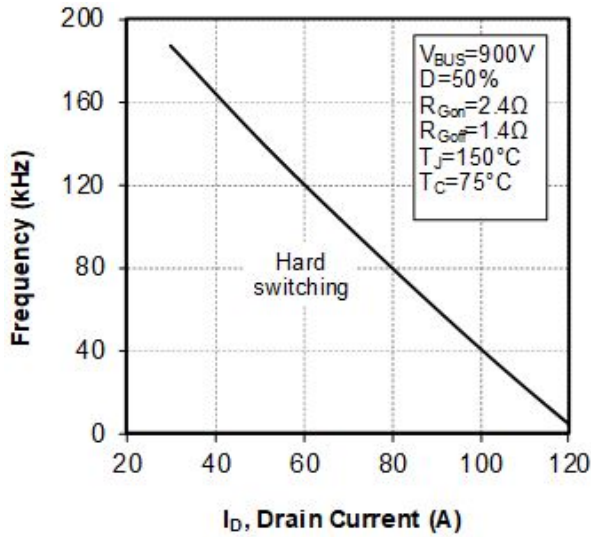


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$



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



## 1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM170TAM23CTPAG device.

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

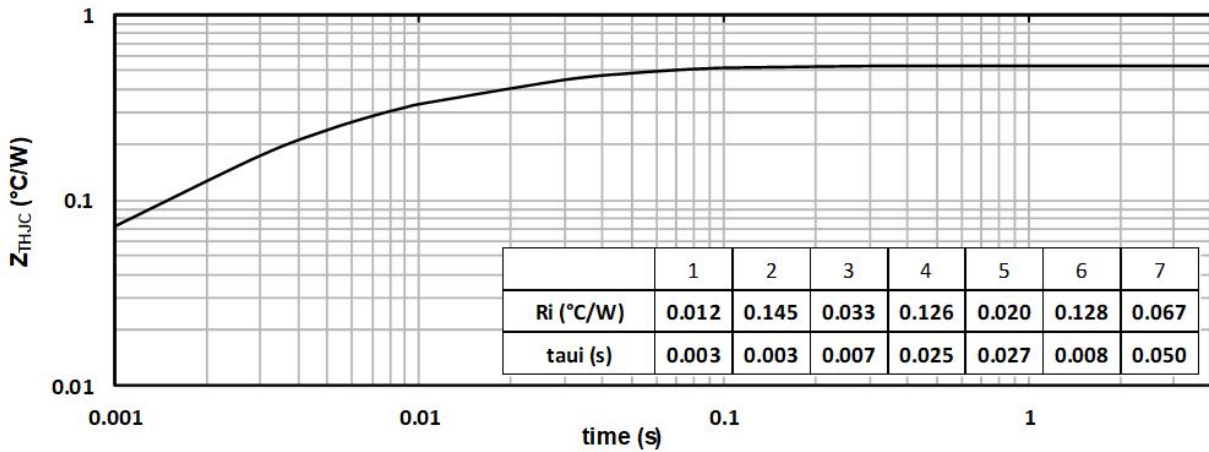


Figure 1-16. Forward Characteristics

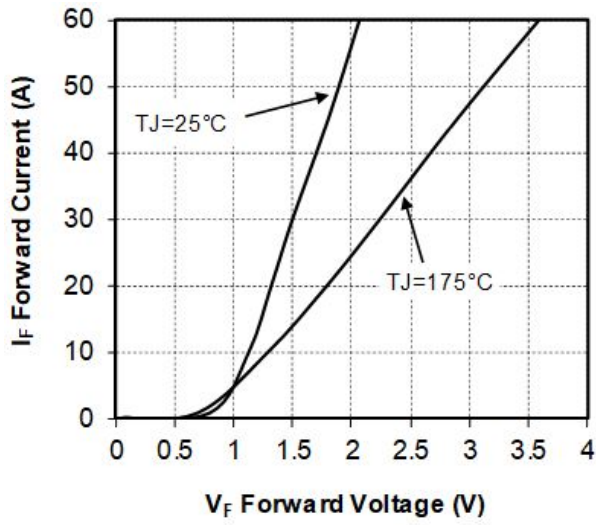
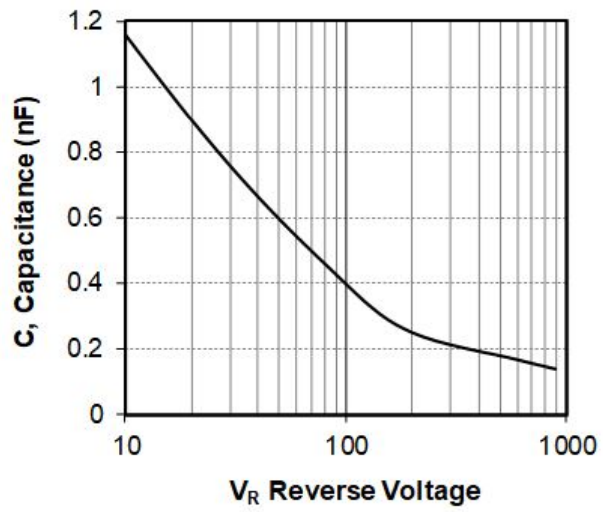


Figure 1-17. Capacitance vs. Reverse Voltage





### 3. Revision History

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

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