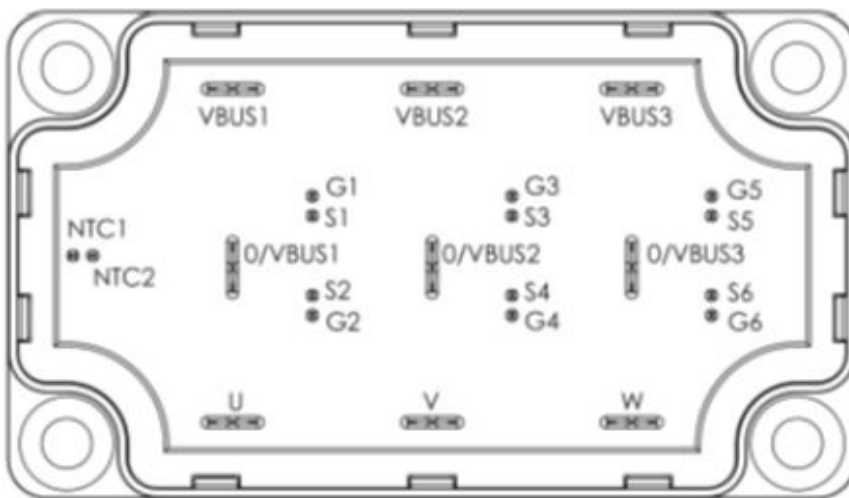
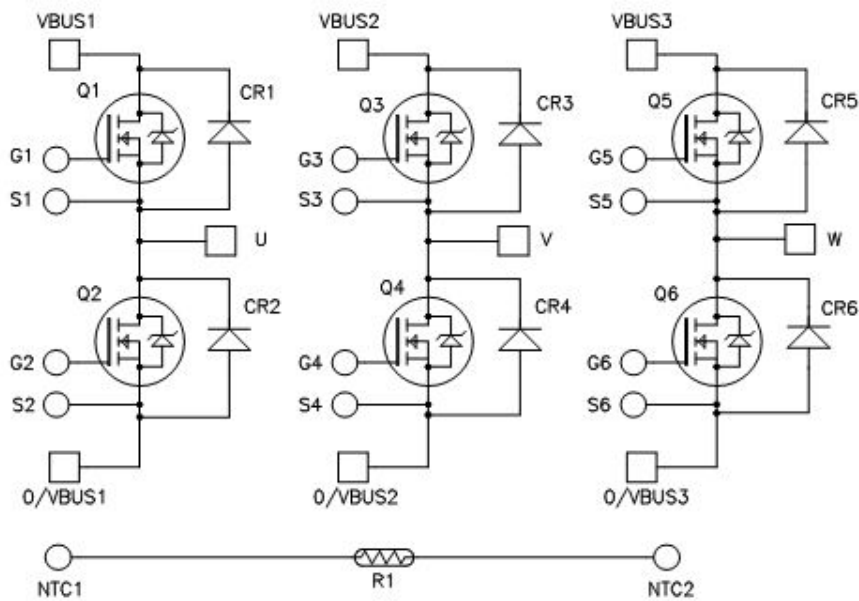


Triple Phase Leg SiC MOSFET Power Module

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

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

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

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_{DS}	Drain-Source voltage		1700	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	122	A
		$T_C = 80\text{ }^{\circ}\text{C}$	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 Ω
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	μA
$R_{DS(on)}$	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 Ω
			$T_J = 175\text{ }^{\circ}\text{C}$	—	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	$I_D = 100\text{ A}$ $R_{G(on)} = 2.4\text{ }\Omega$ $R_{G(off)} = 1.4\text{ }\Omega$	—	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	$V_{Bus} = 900\text{ V}$ $I_D = 100\text{ A}$ $R_{G(on)} = 2.4\text{ }\Omega$ $R_{G(off)} = 1.4\text{ }\Omega$	$T_J = 150\text{ °C}$	—	0.33	
R_{Gint}	Internal gate resistance		—	2.93	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.255	$^{\circ}\text{C/W}$

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	$V_R = 1700\text{ V}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	10	200	μA
			$T_J = 175\text{ }^{\circ}\text{C}$	—	150	—	
I_F	DC forward current	—	$T_C = 125\text{ }^{\circ}\text{C}$	—	30	—	A
V_F	Diode forward voltage	$I_F = 30\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^{\circ}\text{C}$	—	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 ₂₅	Resistance at 25 °C	—	50	—	kΩ
ΔR ₂₅ /R ₂₅	—	—	5	—	%
B _{25/85}	T ₂₅ = 298.15 K	—	3952	—	K
ΔB/B	—	T _C = 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_T: 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

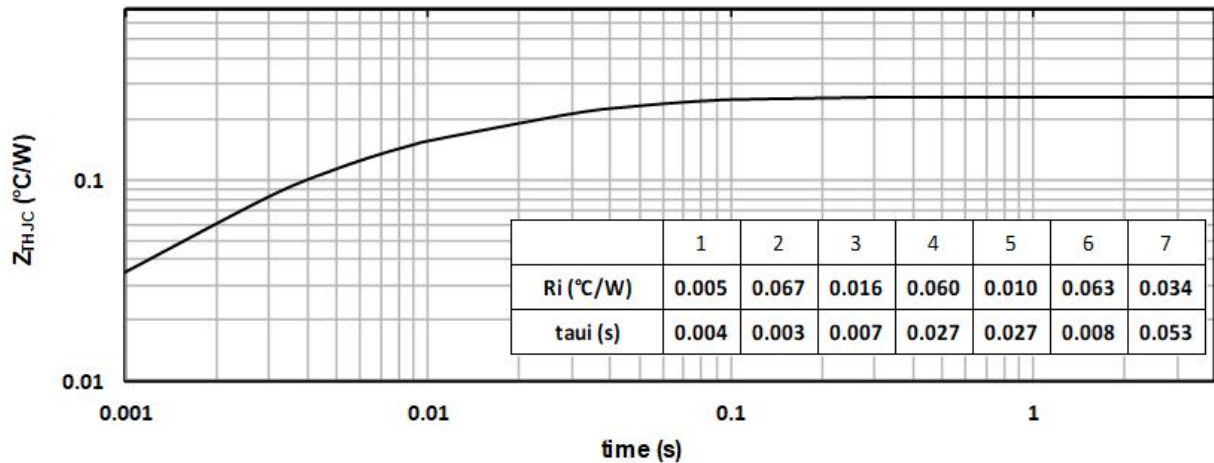


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

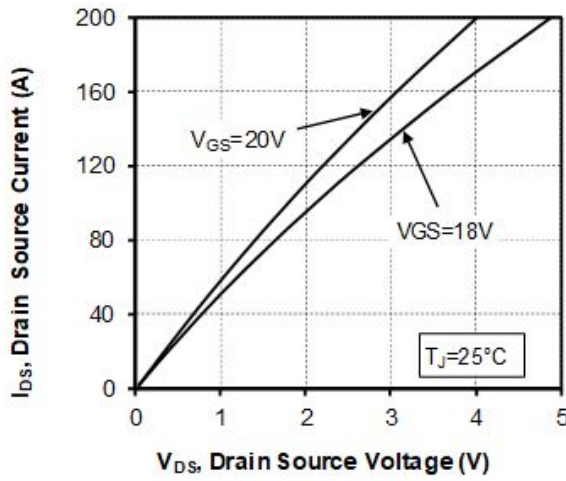


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

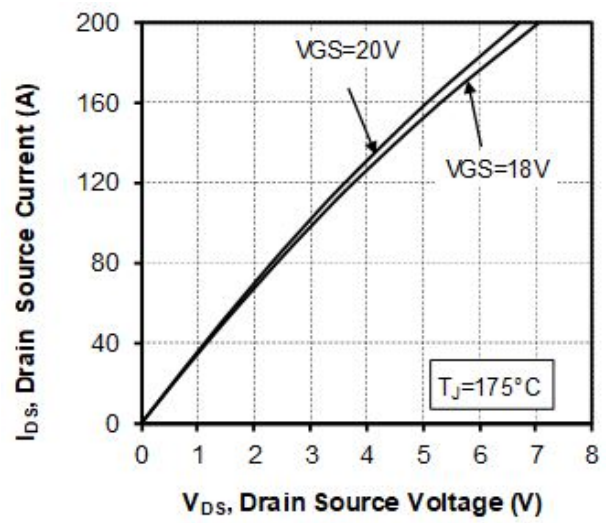


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

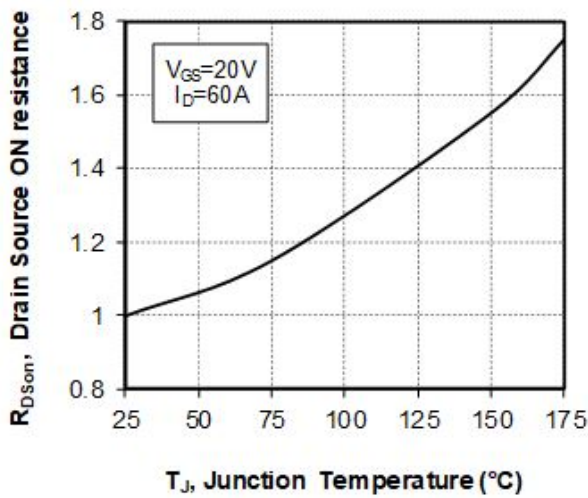


Figure 1-5. Transfer Characteristics

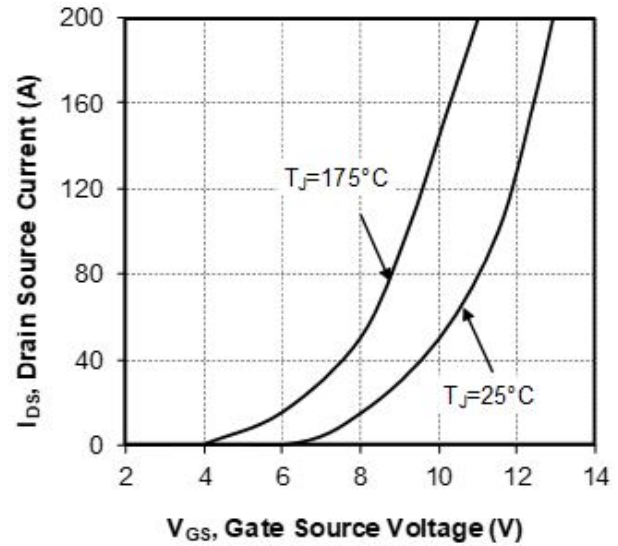


Figure 1-6. Switching Energy vs. Rg

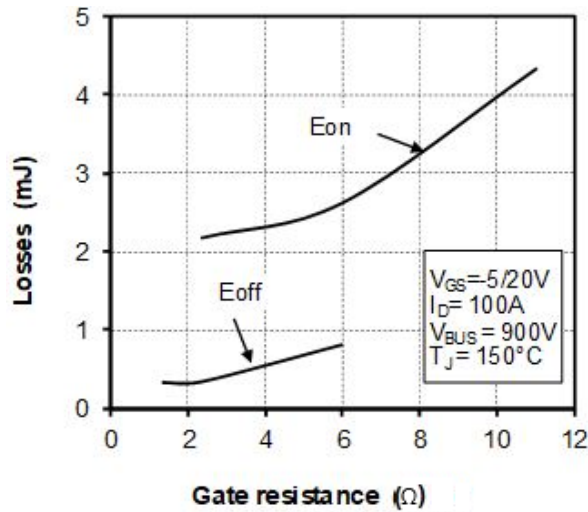


Figure 1-7. Switching Energy vs. Current

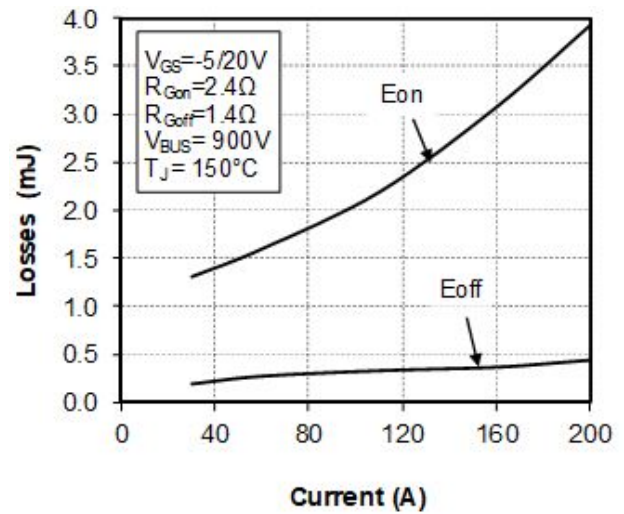


Figure 1-8. Capacitance vs. Drain Source Voltage

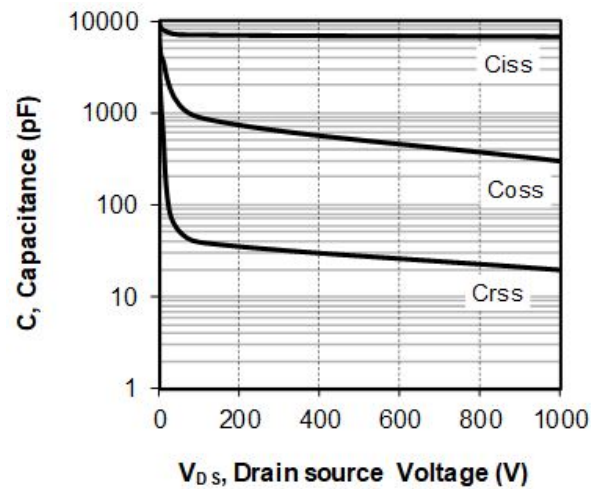


Figure 1-9. Gate Charge vs. Gate Source Voltage

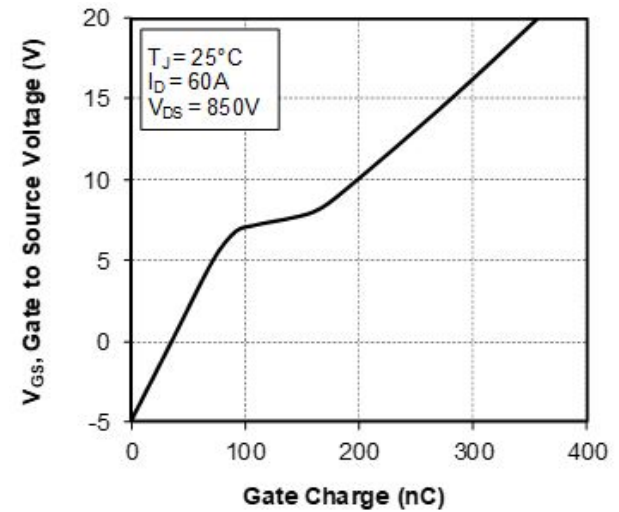


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

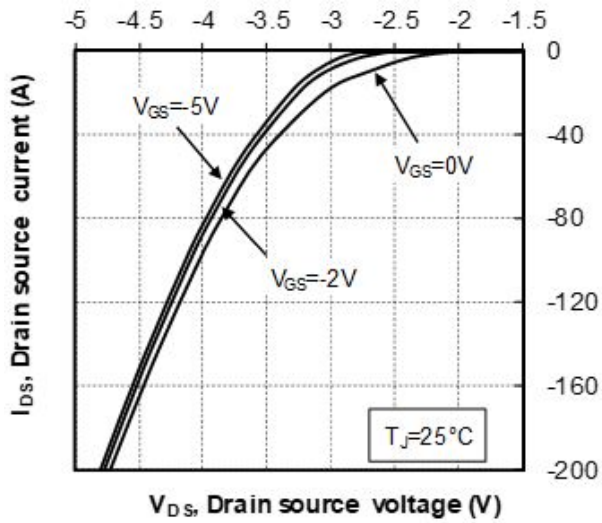


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

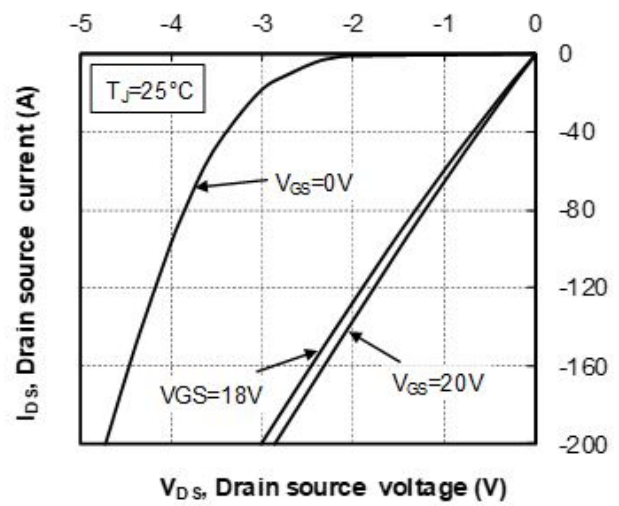


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

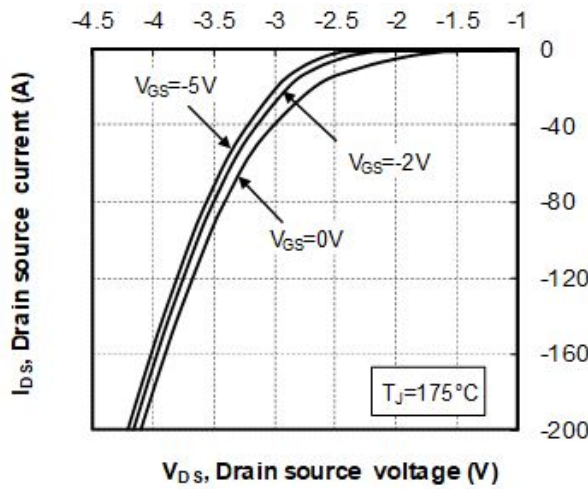


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

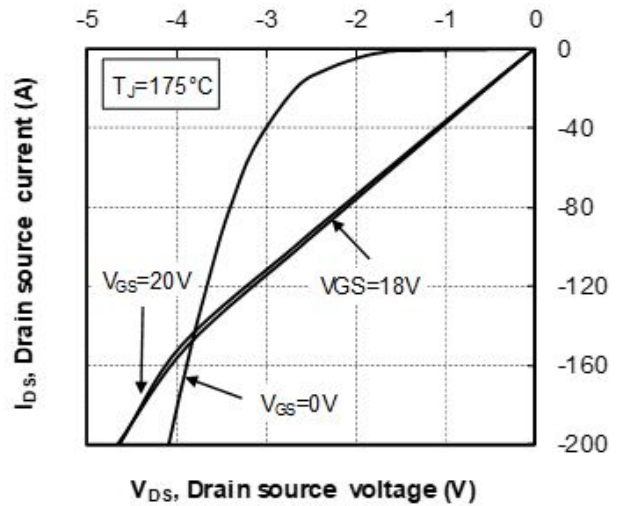
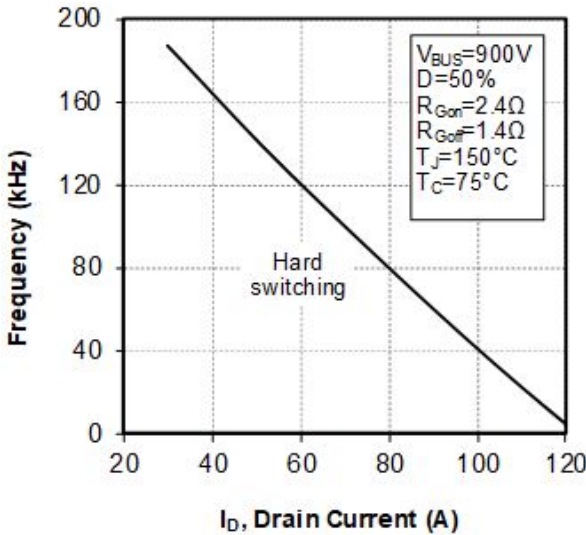


Figure 1-14. Operating Frequency vs Drain Current



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

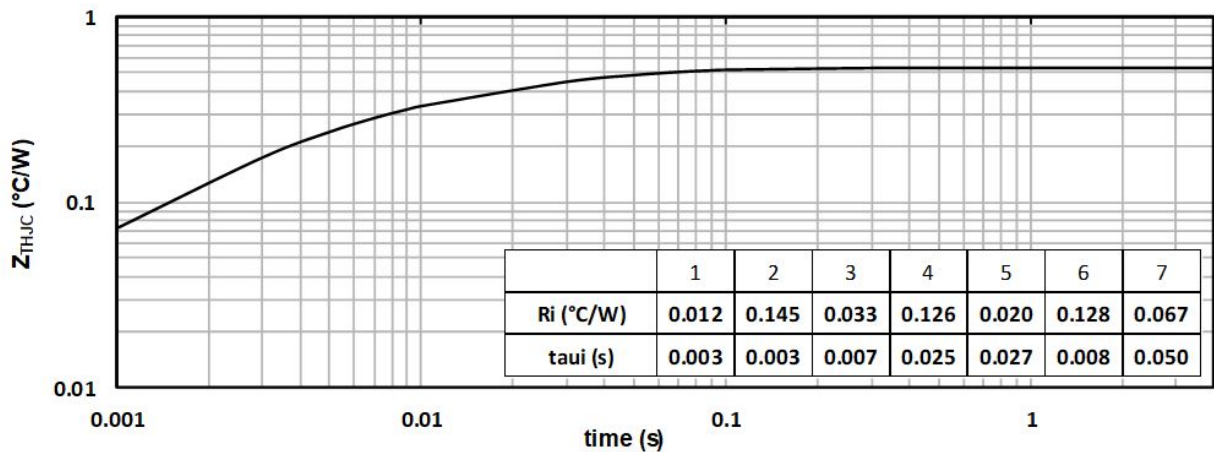


Figure 1-16. Forward Characteristics

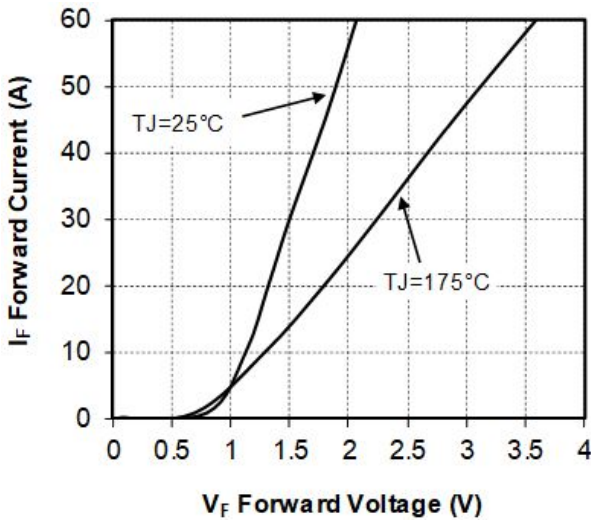
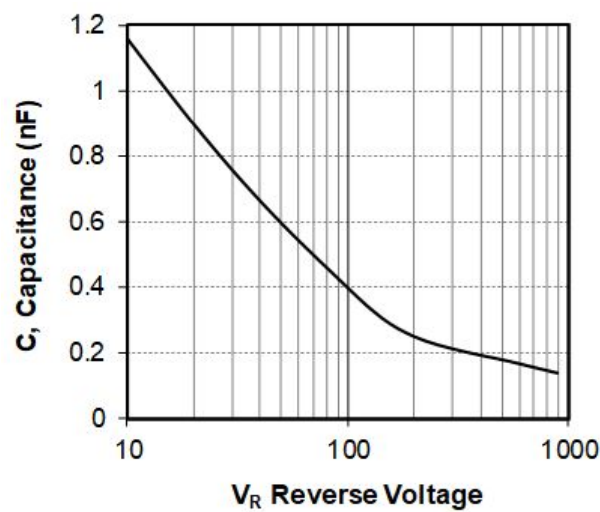


Figure 1-17. Capacitance vs. Reverse Voltage



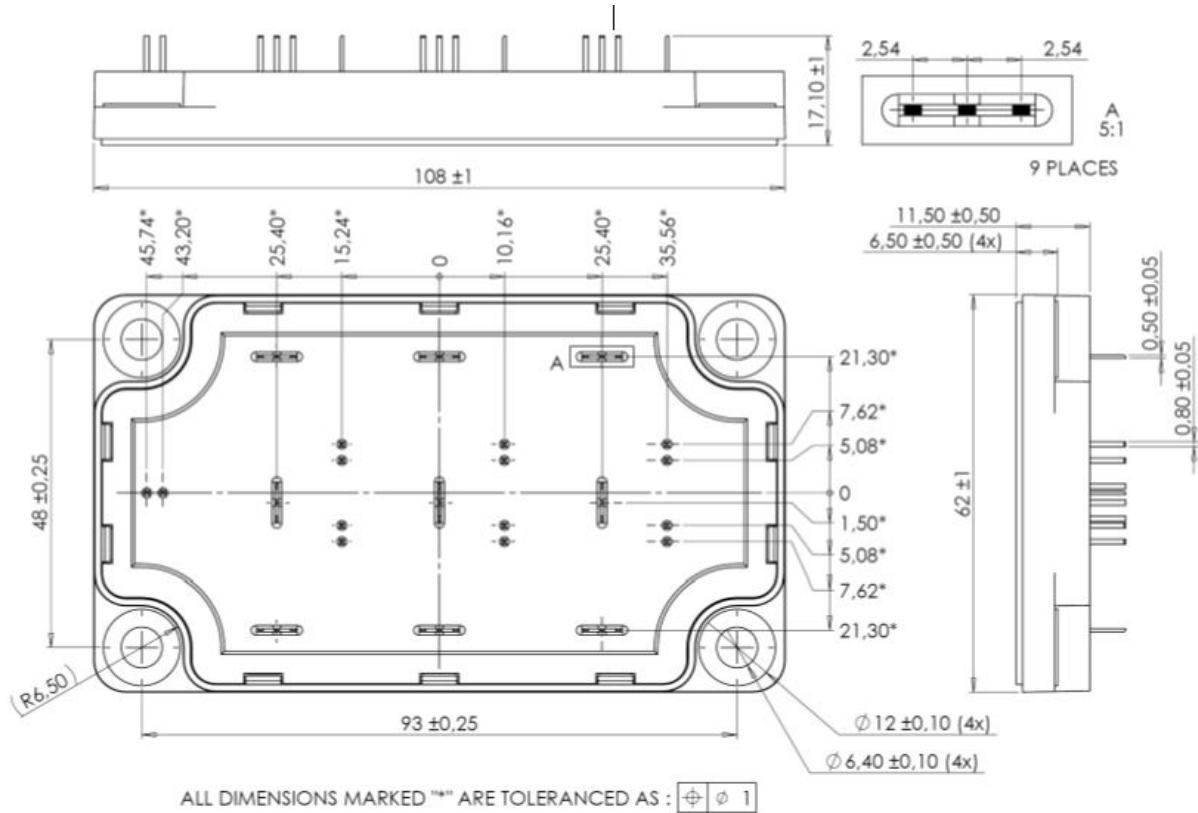
2. Package Specifications

The following section shows the package specification of the MSCSM170TAM23CTPAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170TAM23CTPAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See [AN1902—Mounting Instruction for SP6-P \(12 mm\) 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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