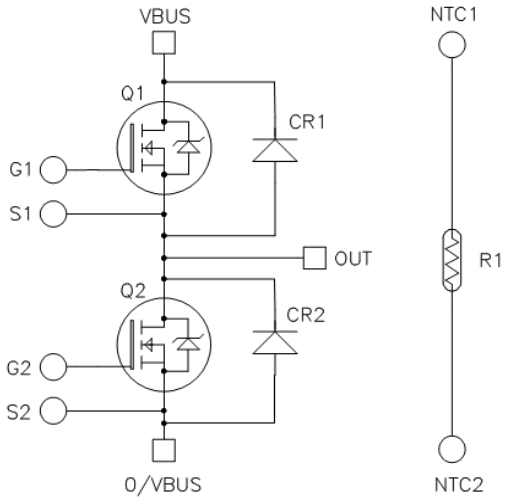
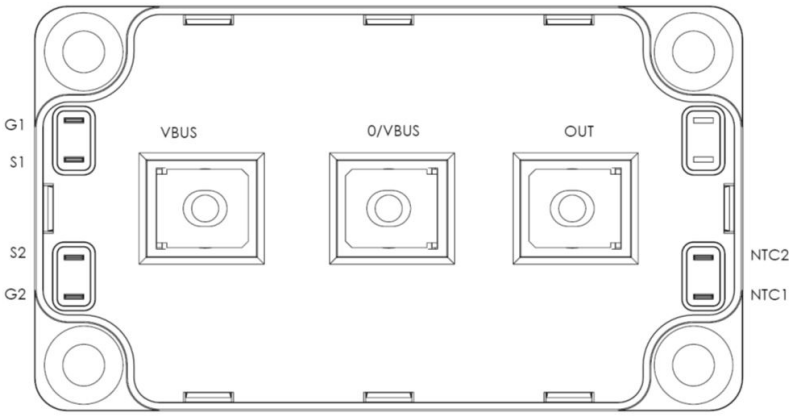
MSCSM170AM039CT6AG

Phase Leg SiC Power Module

Product Overview

The MSCSM170AM039CT6AG device is a 1700 V/523 A phase leg silicon carbide (SiC) power module.





All ratings at T_J = 25 °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 MSCSM170AM039CT6AG 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 MSCSM170AM039CT6AG 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 MSCSM170AM039CT6AG 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 MSCSM170AM039CT6AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM170AM039CT6AG 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 °C	523	A
		T_C = 80 °C	416	
I_{DM}	Pulsed drain current		1000	
V_{GS}	Gate-Source voltage		–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		5	mΩ
P_D	Power dissipation	T_C = 25 °C	2400	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM170AM039CT6AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V; V_{DS} = 1700 V		—	90	900	µA
$R_{DS(on)}$	Drain-Source on resistance	V_{GS} = 20 V I_D = 270 A	T_J = 25 °C	—	3.9	5	mΩ
			T_J = 175 °C	—	6.8	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 22.5 mA		1.8	3.3	—	V
I_{GSS}	Gate-Source leakage current	V_{GS} = 20 V; V_{DS} = 0 V		—	—	900	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM170AM039CT6AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V		—	29.7	—	nF
C_{oss}	Output capacitance	V_{DS} = 1000 V		—	1.3	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.09	—	
Q_g	Total gate charge	V_{GS} = –5 V/20 V		—	1602	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 850 V		—	441	—	
Q_{gd}	Gate-drain charge	I_D = 270 A		—	243	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5 V/20 V		—	75	—	ns
T_r	Rise time	V_{Bus} = 900 V		—	75	—	
$T_{d(off)}$	Turn-off delay time	I_D = 450 A		—	153	—	
T_f	Fall time	T_J = 150 °C R_{GON} = 3.2 Ω R_{GOFF} = 1.8 Ω			56	—	
E_{on}	Turn-on energy	V_{GS} = –5 V/20 V	T_J = 150 °C	—	20.3	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 900 V I_D = 450 A R_{GON} = 3.2 Ω R_{GOFF} = 1.8 Ω	T_J = 150 °C	—	10.8	—	
R_{Gint}	Internal gate resistance			—	0.65	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.063	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM170AM039CT6AG 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 V; I_{SD} = 270 A	—	3.7	—	V
		V_{GS} = –5 V; I_{SD} = 270 A	—	3.9	—	
t_{rr}	Reverse recovery time	I_{SD} = 270 A	—	27	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5 V	—	5.9	—	µC
I_{rr}	Reverse recovery current	V_R = 900 V di_F/dt = 9000 A/µs	—	414	—	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 MSCSM170AM039CT6AG 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 V	T_J = 25 °C	—	70	1400	µA
			T_J = 175 °C	—	1050	—	
I_F	DC forward current		T_C = 125 °C	—	210	—	A
V_F	Diode forward voltage	I_F = 210 A	T_J = 25 °C	—	1.5	1.8	V
			T_J = 175 °C	—	2.3	—	
Q_C	Total capacitive charge	V_R = 900 V		—	1610	—	nC
C	Total capacitance	f = 1 MHz, V_R = 600 V		—	1169	—	pF
		f = 1 MHz, V_R = 900 V		—	966	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.09	°C/W

1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM170AM039CT6AG device.

Table 1-6. Thermal and Package Characteristics

Symbol	Characteristic			Min	Max	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz			4000	—	V
T_J	Operating junction temperature range			–40	175	°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 MSCSM170AM039CT6AG device.

Table 1-7. Temperature Sensor NTC

Symbol	Characteristic		Min	Typ	Max	Unit
R_{25}	Resistance at 25 °C		—	50	—	kΩ
$\Delta R_{25}/R_{25}$	—		—	5	—	%
$B_{25/85}$	T_{25} = 298.15 K		—	3952	—	K
ΔB/B	—	T_C = 100 °C	—	4	—	%

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

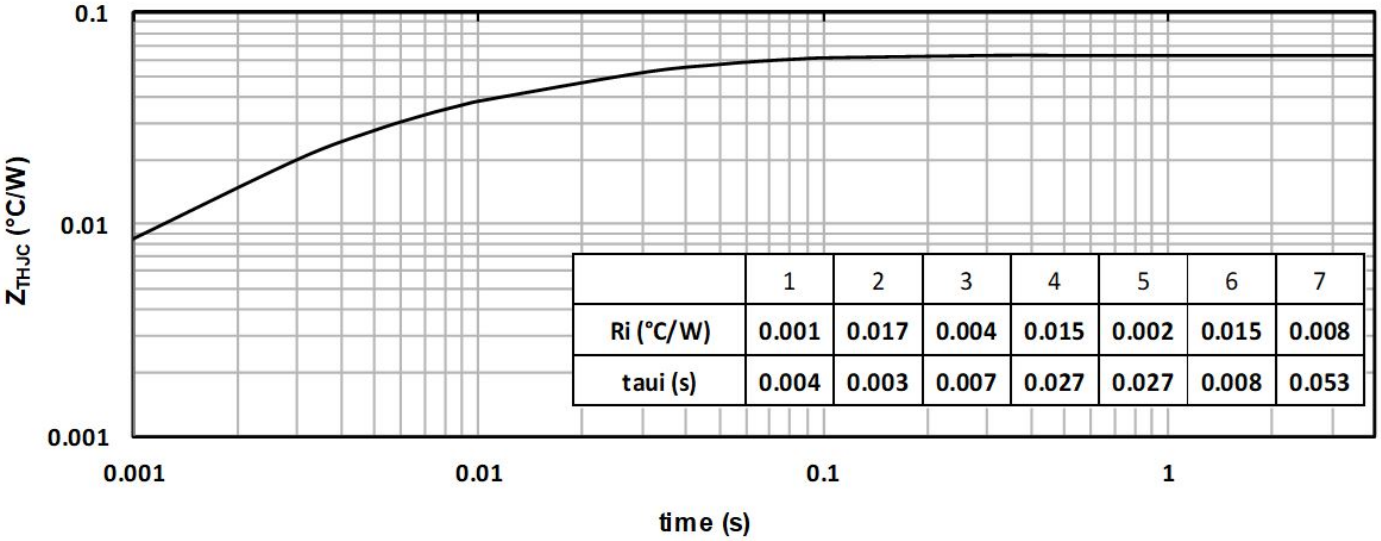
T: Thermistor temperature
R_T: Thermistor value at T

Note: See APT0406—Using NTC Temperature Sensor Integrated into Power Module for more information.

1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM170AM039CT6AG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.001	0.017	0.004	0.015	0.002	0.015	0.008
taui (s)	0.004	0.003	0.007	0.027	0.027	0.008	0.053

Figure 1-2. Output Characteristics, T_J = 25 °C

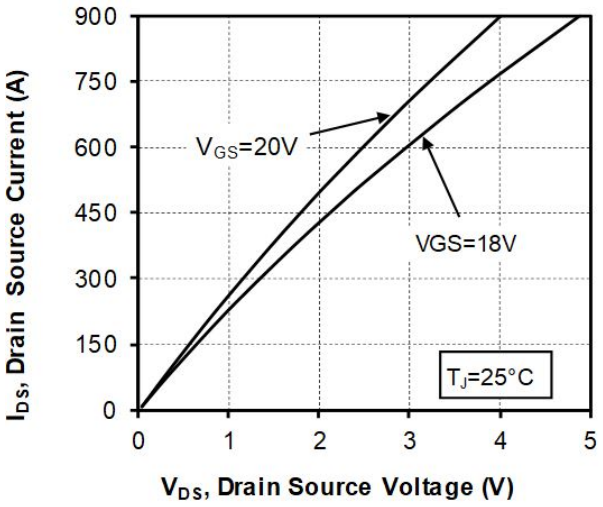


Figure 1-3. Output Characteristics, T_J = 175 °C

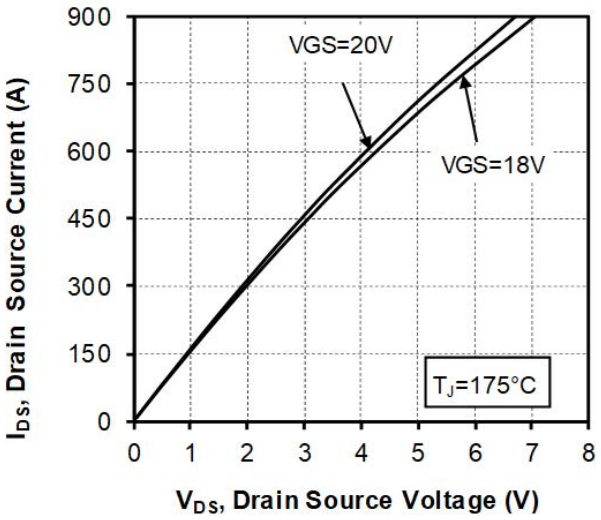


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

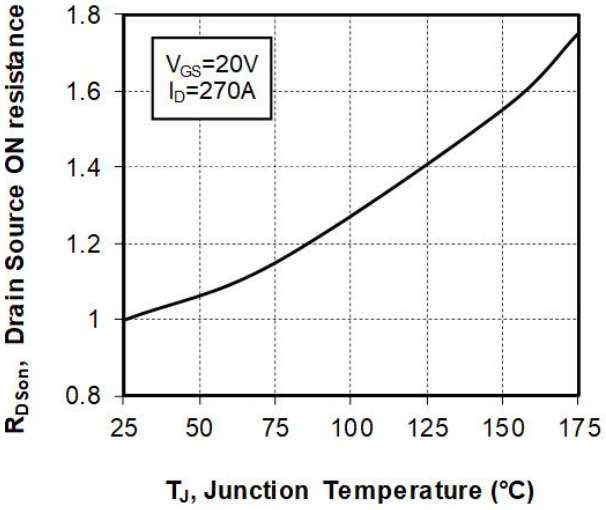


Figure 1-5. Transfer Characteristics

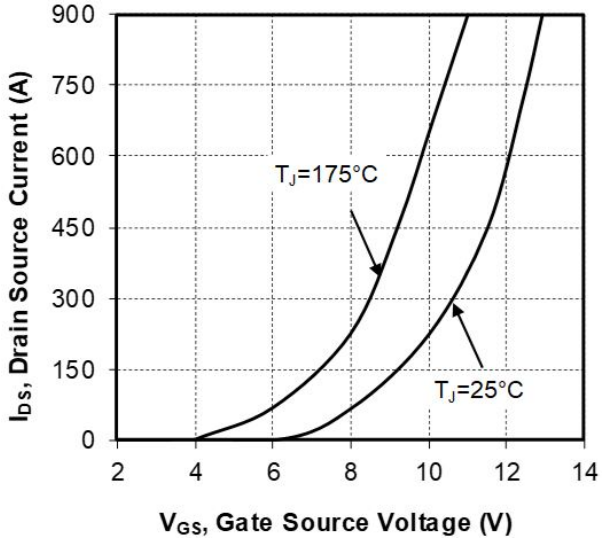


Figure 1-6. Switching Energy vs. Rg

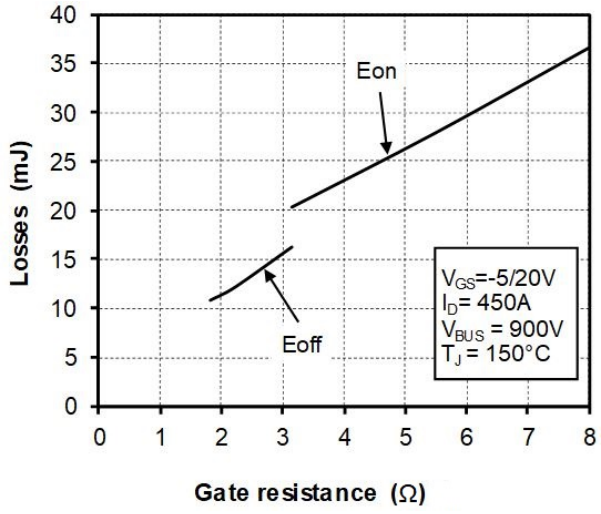


Figure 1-7. Switching Energy vs. Current

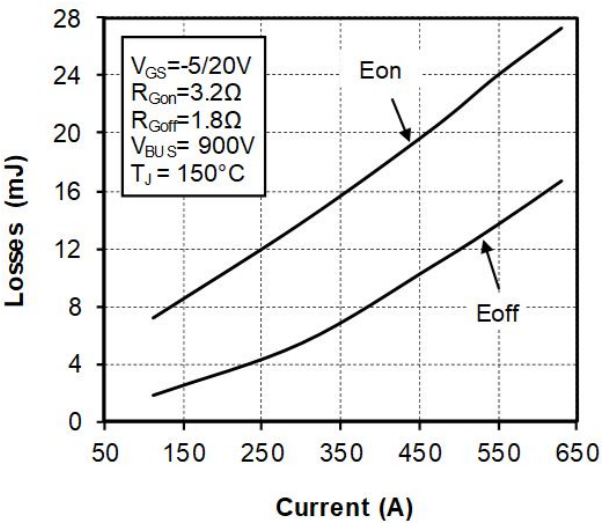


Figure 1-8. Capacitance vs. Drain Source Voltage

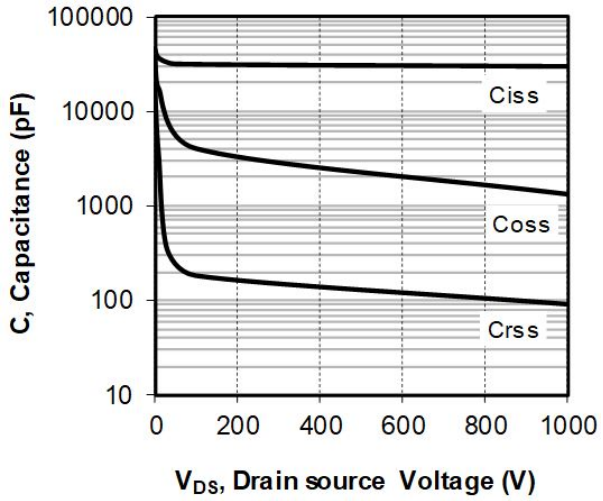


Figure 1-9. Gate Charge vs. Gate Source Voltage

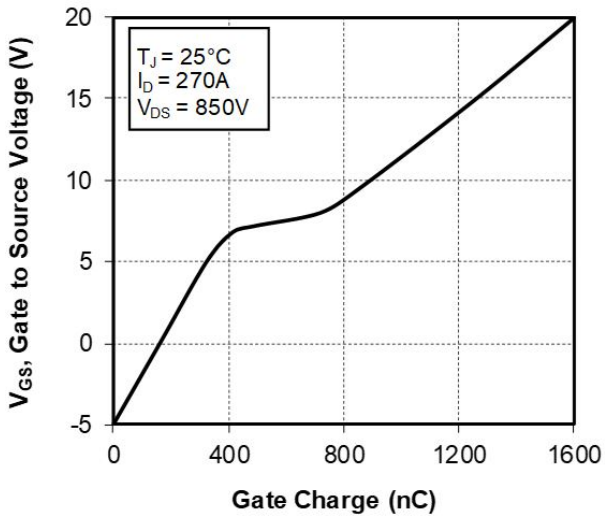


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

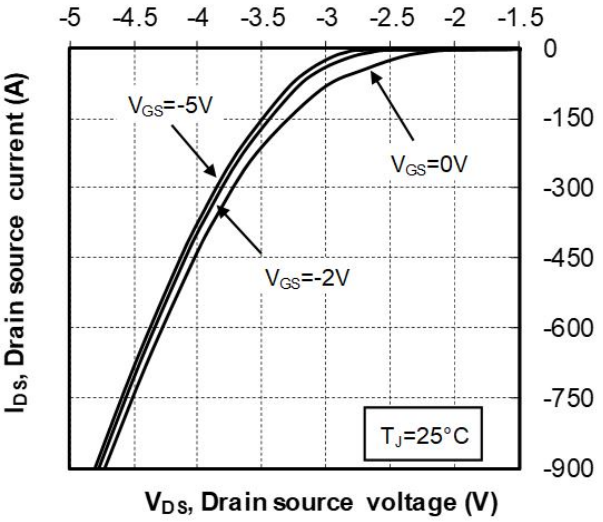


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

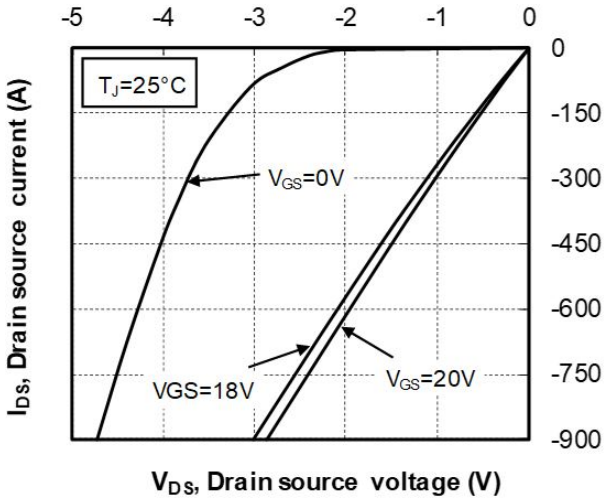


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

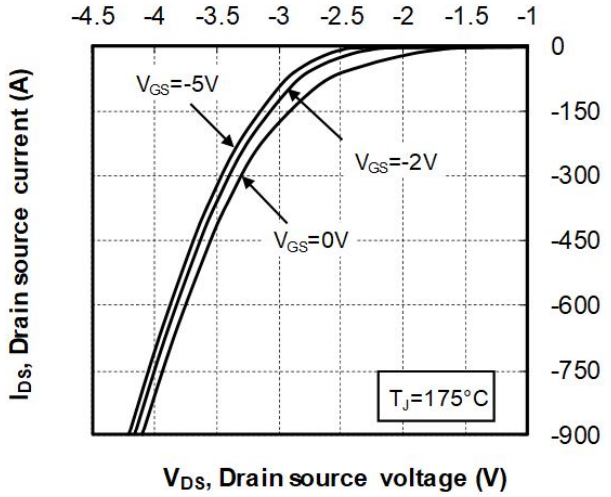


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

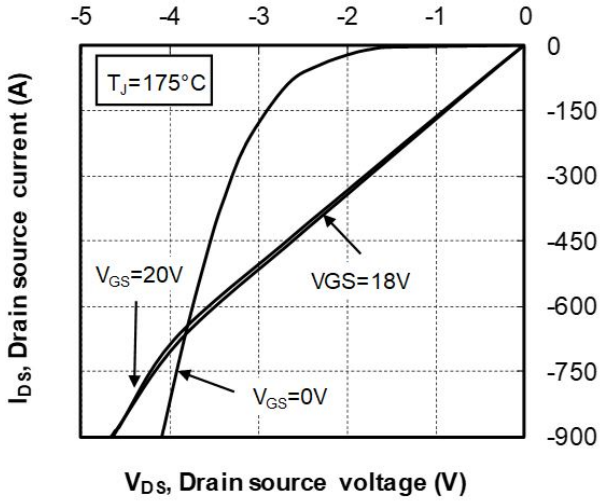
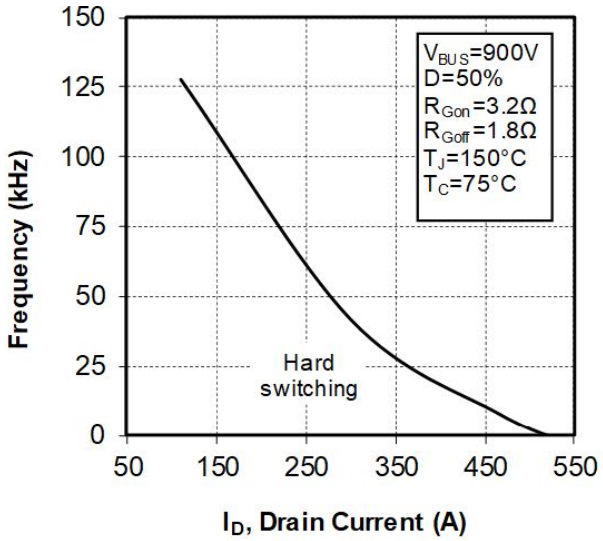


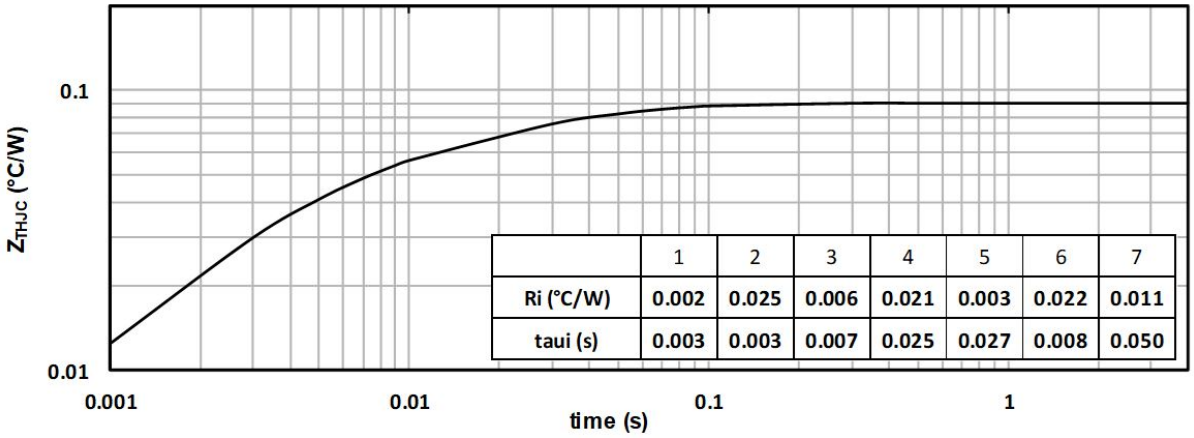
Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM170AM039CT6AG device.

Figure 1-15. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.025	0.006	0.021	0.003	0.022	0.011
taui (s)	0.003	0.003	0.007	0.025	0.027	0.008	0.050

Figure 1-16. Forward Characteristics

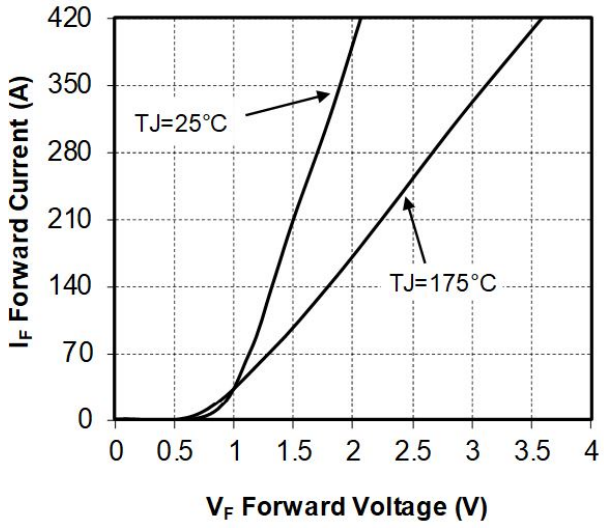
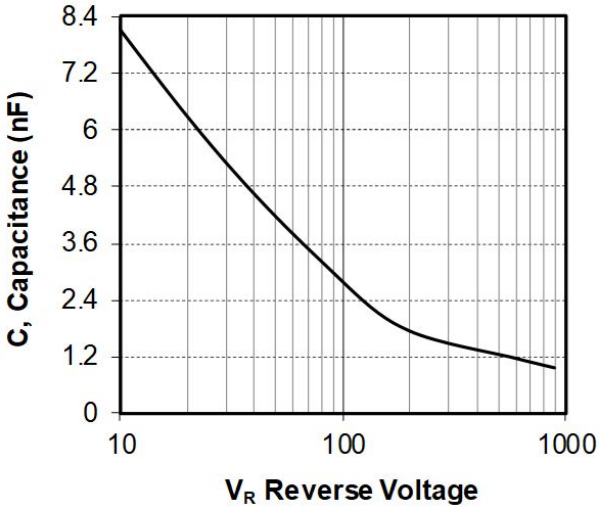


Figure 1-17. Capacitance vs. Reverse Voltage



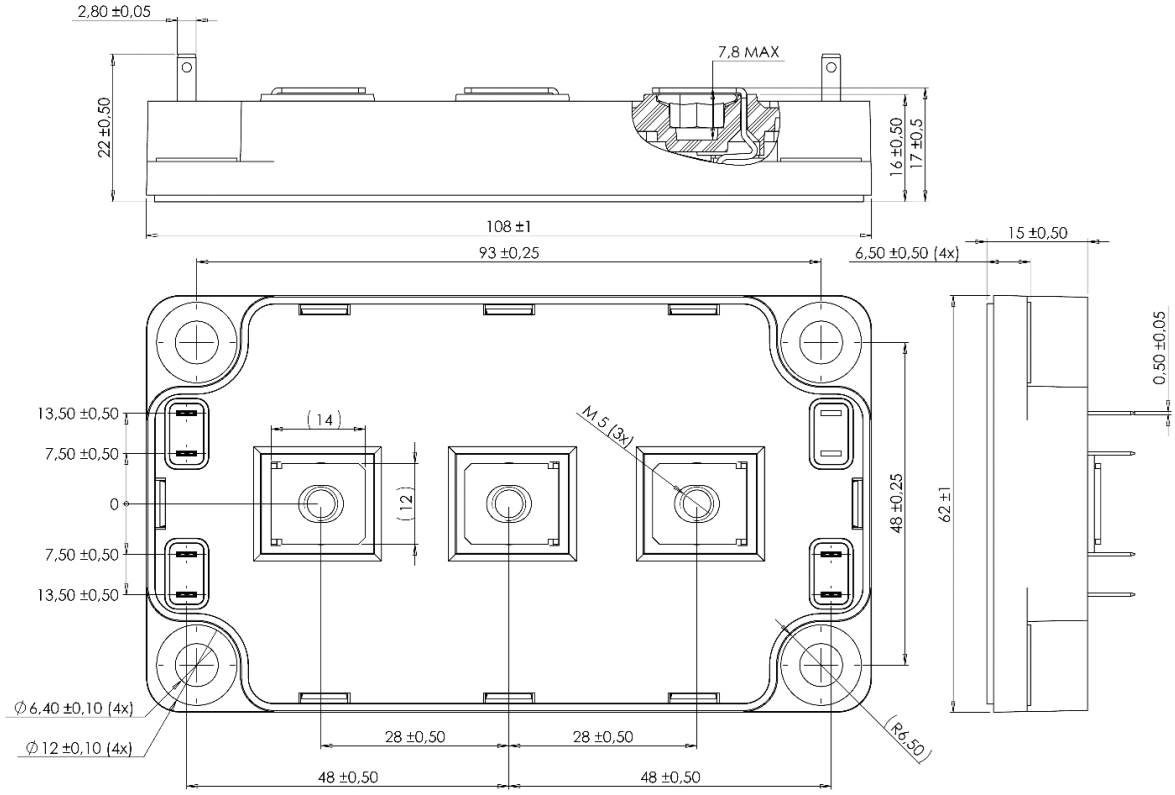
2. Package Specifications

The following section shows the package specification of the MSCSM170AM039CT6AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170AM039CT6AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



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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