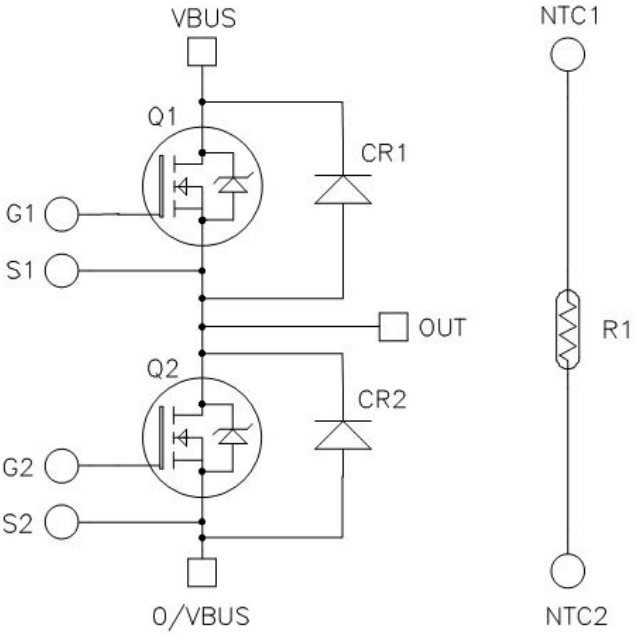
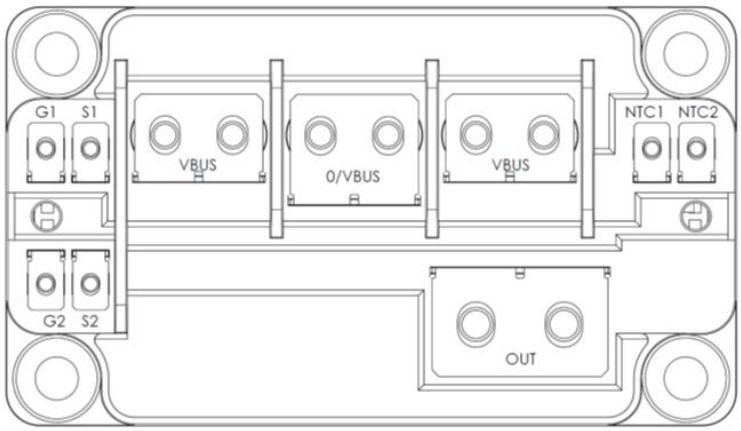
MSCSM170AM029CT6LIAG

Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM170AM029CT6LIAG device is a very low stray inductance phase leg 1700 V, 676 A silicon Carbide (SiC) MOSFET 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 MSCSM170AM029CT6LIAG 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
- M4 and M5 power connectors
- M2.5 signal connectors
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM170AM029CT6LIAG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS Compliant

Application

The following are the applications of MSCSM170AM029CT6LIAG device:

- 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 MSCSM170AM029CT6LIAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170AM029CT6LIAG 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	676	A
		T_C = 80 °C	538	
I_{DM}	Pulsed drain current		1350	
V_{GS}	Gate-source voltage		–10/23	V
$R_{DS(on)}$	Drain-source ON resistance		3.75	mΩ
P_D	Power dissipation	T_C = 25 °C	3000	W

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170AM029CT6LIAG 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		—	120	1200	µA
$R_{DS(on)}$	Drain–Source on resistance	V_{GS} = 20 V I_D = 360 A	T_J = 25 °C	—	2.9	3.75	mΩ
			T_J = 175 °C	—	5.1	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 30 mA		1.8	3.3	—	V
I_{GSS}	Gate–Source leakage current	V_{GS} = 20 V; V_{DS} = 0 V		—	—	1200	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170AM029CT6LIAG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V		—	39.6	—	nF
C_{oss}	Output capacitance	V_{DS} = 1000 V		—	1.8	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.12	—	
Q_g	Total gate charge	V_{GS} = –5 V/20 V		—	2136	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 850 V		—	588	—	
Q_{gd}	Gate-drain charge	I_D = 360 A		—	324	—	
$T_{d(on)}$	Turn-on delay time	T_J = 150 °C		—	74	—	ns
T_r	Rise time	V_{GS} = –5 V/20 V		—	63	—	
$T_{d(off)}$	Turn-off delay time	V_{Bus} = 900 V		—	163	—	
T_f	Fall time	I_D = 600 A R_G = 0.5 Ω			48	—	
E_{on}	Turn-on energy	V_{GS} = –5 V/20 V	T_J = 150 °C	—	24.2	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 900 V I_D = 600 A R_G = 0.5 Ω	T_J = 150 °C	—	12.6	—	
R_{Gint}	Internal gate resistance			—	0.79	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.05	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170AM029CT6LIAG 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} = 360 A	—	3.7	—	V
		V_{GS} = –5 V; I_{SD} = 360 A	—	3.9	—	
t_{rr}	Reverse recovery time	I_{SD} = 360 A; V_{GS} = –5 V V_R = 900 V; di_F/dt = 1200 A/µs	—	27	—	ns
Q_{rr}	Reverse recovery charge		—	7.8	—	µC
I_{rr}	Reverse recovery current		—	552	—	A

1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of the MSCSM170AM029CT6LIAG device.

Table 1-5. SiC 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	—	300	1200	µA
			T_J = 175 °C	—	1500	—	
I_F	DC forward current	—	T_C = 125 °C	—	300	—	A
V_F	Diode forward voltage	I_F = 300 A	T_J = 25 °C	—	1.5	1.8	V
			T_J = 175 °C	—	2	—	
Q_C	Total capacitive charge	V_R = 900 V		—	2460	—	nC
C	Total capacitance	f = 1 MHz, V_R = 600 V		—	1800	—	pF
		f = 1 MHz, V_R = 900 V		—	1500	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.062	°C/W

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170AM029CT6LIAG 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	For terminals	M2.5	0.4	0.6	N.m
			M4	2	3	
			M5	2	3.5	
		To heatsink	M6	3	5	
L_{DC}	Module stray inductance between V_{Bus} and 0/V_{Bus}			—	3	nH
Wt	Package weight			—	320	g

The following table lists the temperature sensor NTC of the MSCSM170AM029CT6LIAG 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	—	%

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

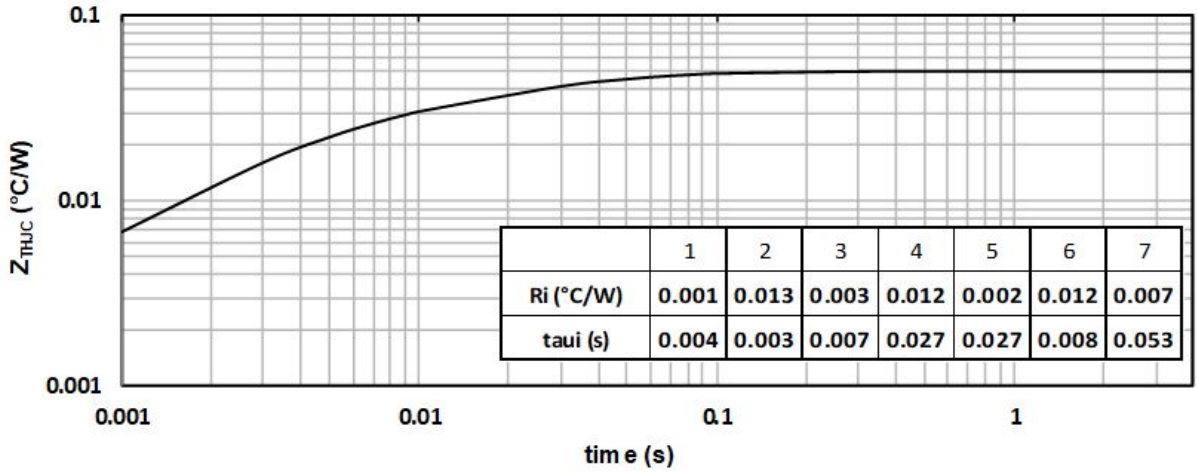
T: Thermistor temperature
R_T: Thermistor value at T

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

1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM170AM029CT6LIAG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.001	0.013	0.003	0.012	0.002	0.012	0.007
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

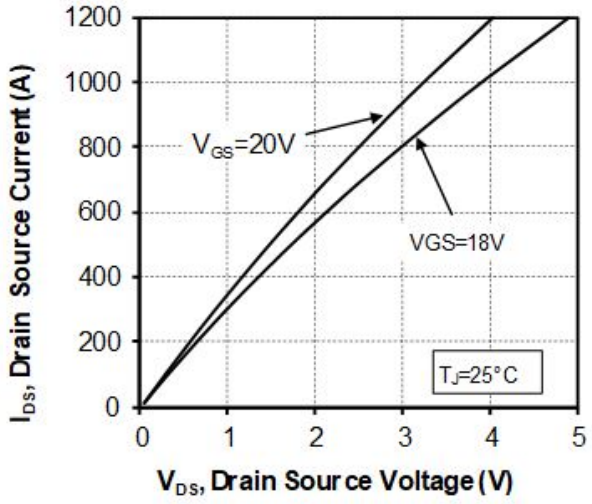


Figure 1-3. Output Characteristics, T_J = 175 °C

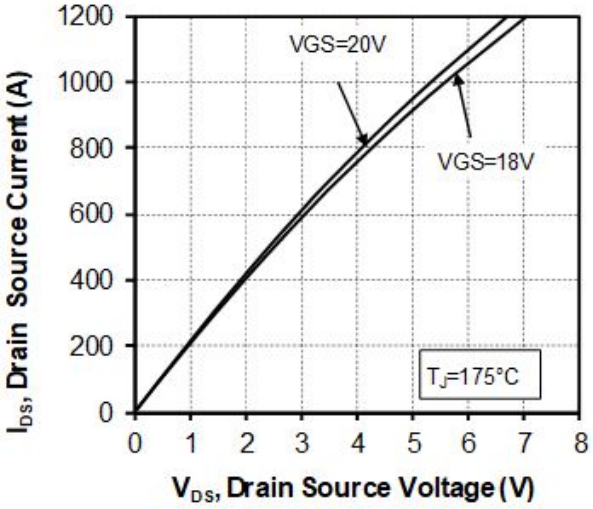


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

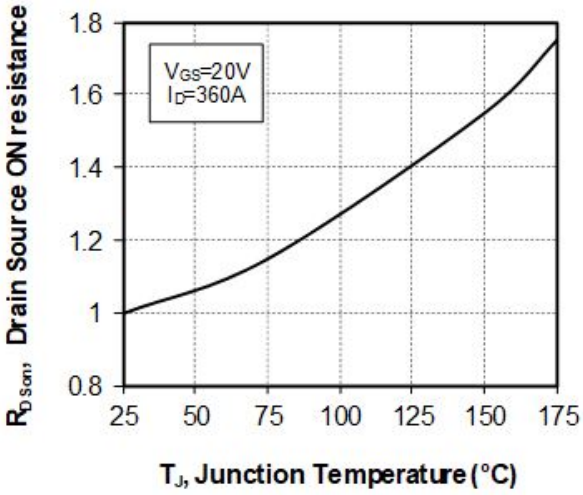


Figure 1-5. Transfer Characteristics

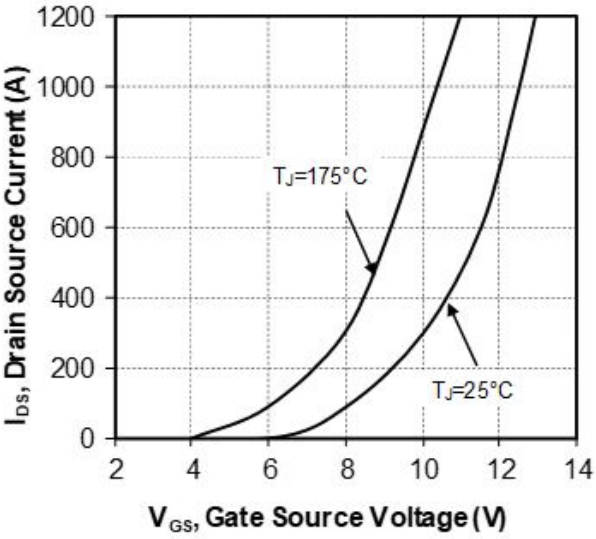


Figure 1-6. Switching Energy vs. Rg

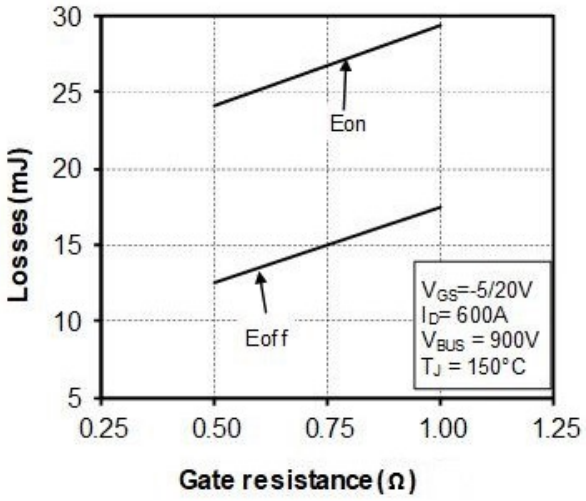


Figure 1-7. Switching Energy vs. Current

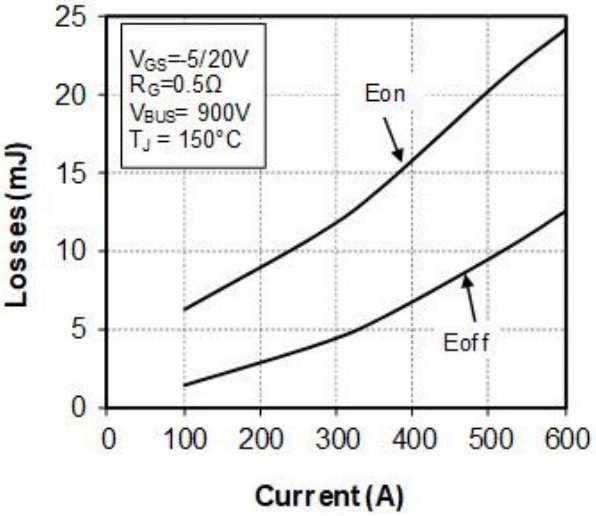


Figure 1-8. Capacitance vs. Drain Source Voltage

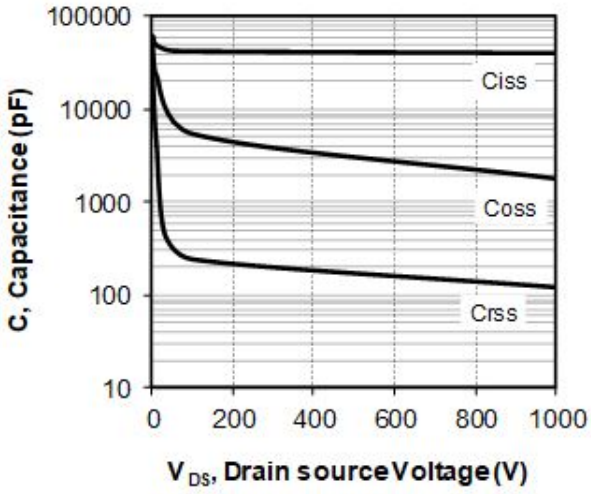


Figure 1-9. Gate Charge vs. Gate Source Voltage

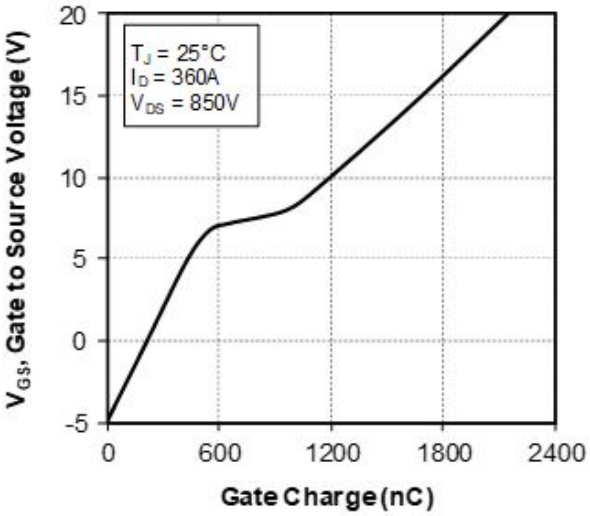


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

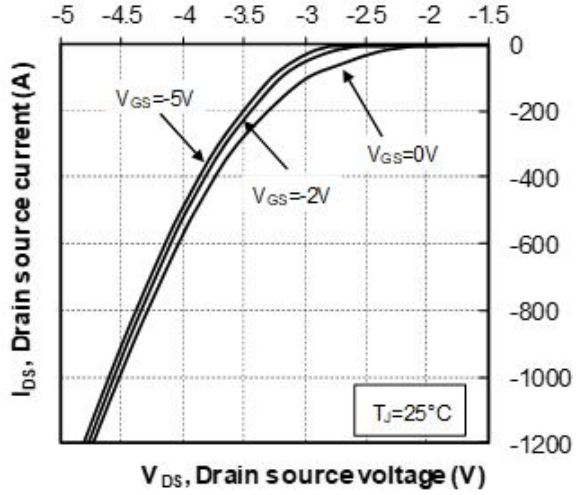


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

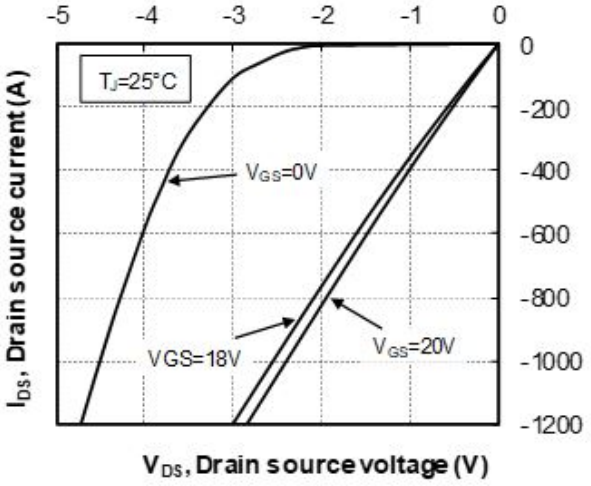


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

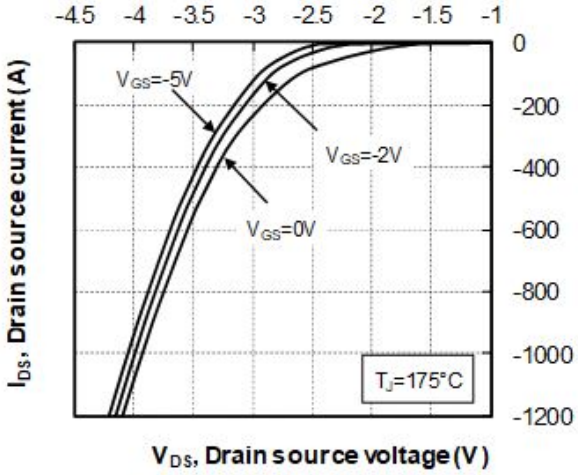


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

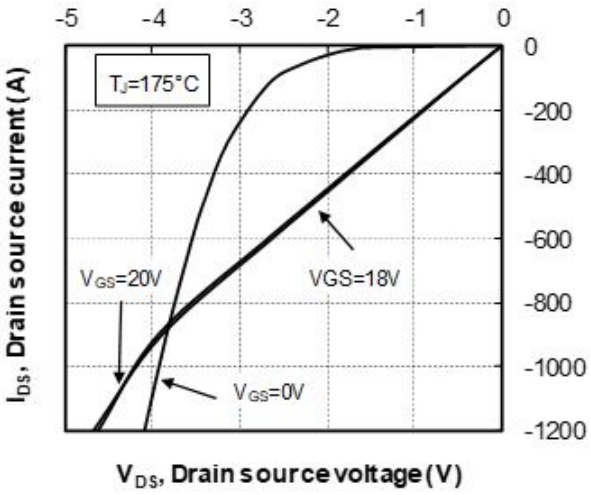
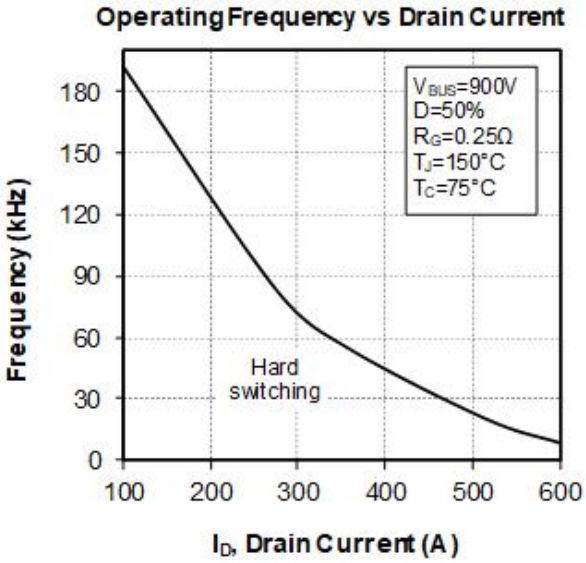


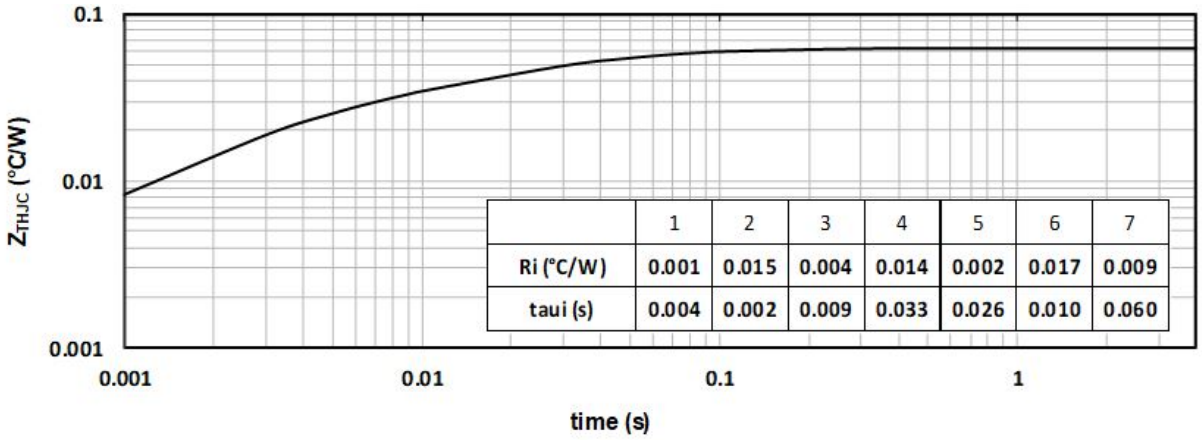
Figure 1-14. Operating Frequency vs Drain Current



1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM170AM029CT6LIAG device.

Figure 1-15. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.001	0.015	0.004	0.014	0.002	0.017	0.009
taui (s)	0.004	0.002	0.009	0.033	0.026	0.010	0.060

Figure 1-16. Forward Characteristics

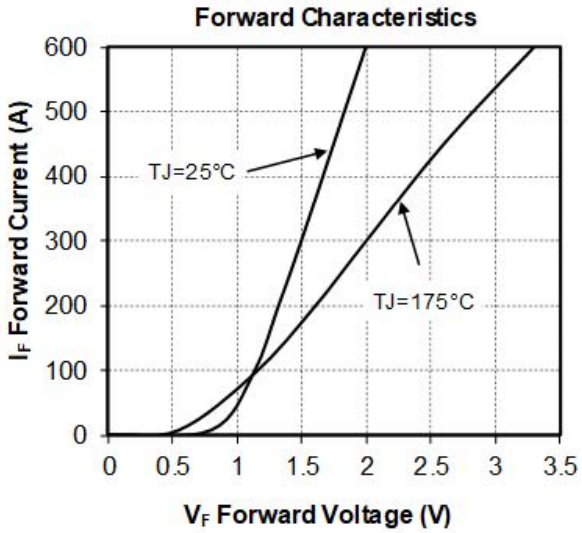
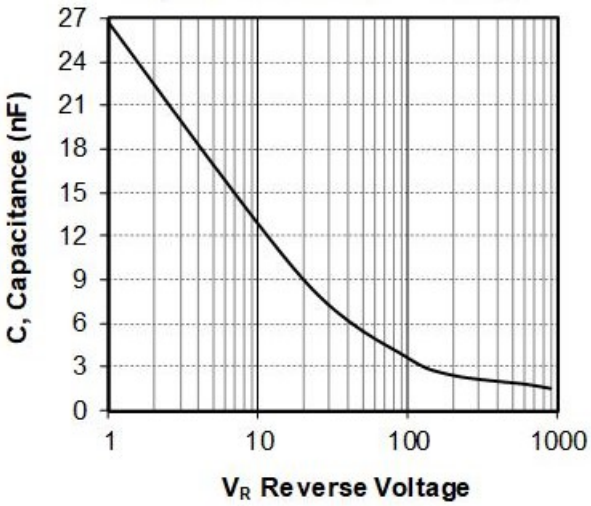


Figure 1-17. Capacitance vs. Reverse Voltage



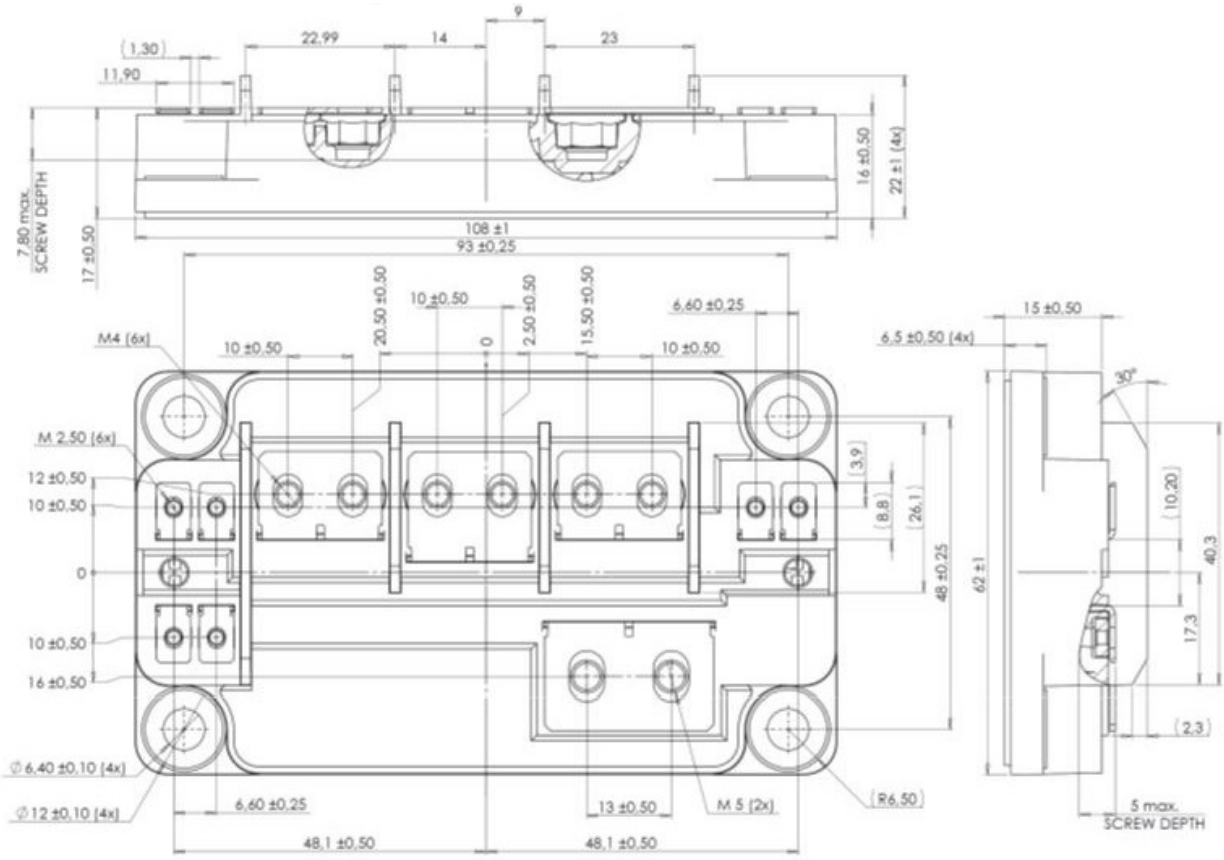
2. Package Specifications

The following section shows the package specification of the MSCSM170AM029CT6LIAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170AM029CT6LIAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See AN1911—Mounting Instructions for SP6 Low Inductance Power Module for more information.

3. Revision History

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

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