MSCSM70AM025CT6LIAG

Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM70AM025CT6LIAG device is a very low stray inductance phase leg 700 V/689 A Silicon Carbide (SiC) MOSFET power module.

Figure 1. MSCSM70AM025CT6LIAG Electric Schematic

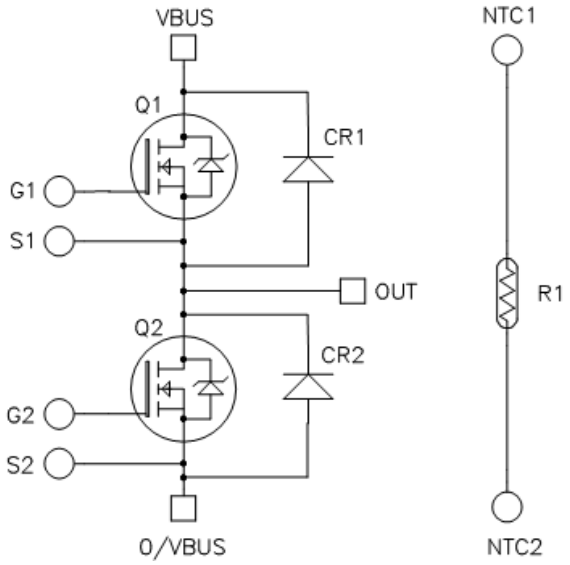
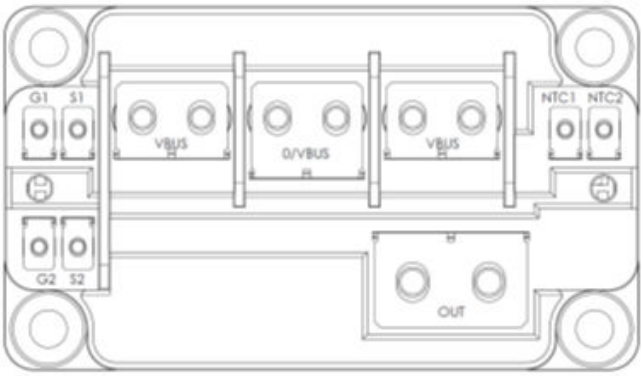


Figure 2. MSCSM70AM025CT6LIAG Pinout Location



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 MSCSM70AM025CT6LIAG 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 MSCSM70AM025CT6LIAG 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

Applications

The following are the applications of MSCSM70AM025CT6LIAG 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 MSCSM70AM025CT6LIAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table shows the absolute maximum ratings (per SiC MOSFET) of the MSCSM70AM025CT6LIAG device. All ratings at T_J = 25 °C, unless otherwise specified.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-source voltage		700	V
I_D	Continuous drain current	T_C = 25 °C	689[1]	A
		T_C = 80 °C	549[1]	
I_{DM}	Pulsed drain current		1400	
V_{GS}	Gate-source voltage		–10/25	V
$R_{DS(on)}$	Drain-source ON resistance		3.2	mΩ
P_D	Power dissipation	T_C = 25 °C	1882	W

Note:

1. Specification of the SiC MOSFET device but output current must be limited due to size of power connectors.

The following table shows the electrical characteristics (per SiC MOSFET) of the MSCSM70AM025CT6LIAG 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} = 700 V		—	—	600	µA
R_{DSon}	Drain-source on resistance	V_{GS} = 20 V I_D = 240 A	T_J = 25 °C	—	2.5	3.2	mΩ
			T_J = 175 °C	—	3.1	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 24 mA		1.9	2.4	—	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20 V; V_{DS} = 0 V		—	—	0.6	µA

The following table shows the dynamic characteristics (per SiC MOSFET) of the MSCSM70AM025CT6LIAG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V	—	27	—	nF
C_{oss}	Output capacitance	V_{DS} = 700 V	—	3	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz	—	0.17	—	
Q_g	Total gate charge	V_{GS} = –5 V/20 V	—	1290	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 470 V	—	348	—	
Q_{gd}	Gate-drain charge	I_D = 240 A	—	210	—	
$T_{d(on)}$	Turn-on delay time	T_J = 150 °C	—	63	—	ns
T_r	Rise time	V_{GS} = –5 V/20 V	—	43	—	
$T_{d(off)}$	Turn-off delay time	V_{Bus} = 400 V	—	155	—	
T_f	Fall time	I_D = 480 A R_G = 0.25 Ω		48	—	
E_{on}	Turn-on energy	V_{GS} = –5 V/20 V	—	3.8	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400 V I_D = 480 A R_G = 0.25 Ω	—	4.5	—	
R_{Gint}	Internal gate resistance		—	1.25	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.08	°C/W

The following table shows the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM70AM025CT6LIAG 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} = 240 A	—	3.4	—	V
		V_{GS} = –5 V; I_{SD} = 240 A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 240 A; V_{GS} = –5 V	—	38	—	ns
Q_{rr}	Reverse recovery charge	V_R = 470 V; di_F/dt = 6000 A/µs	—	1.9	—	µC
I_{rr}	Reverse recovery current		—	89	—	A

1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table shows the SiC diode ratings and characteristics of the MSCSM70AM025CT6LIAG 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	—		—	—	700	V
I_{RM}	Reverse leakage current	V_R = 700 V	T_J = 25 °C	—	0.09	1.2	mA
			T_J = 175 °C	—	1.5	—	
I_F	DC forward current	—	T_C = 65 °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	—	1.9	—	
Q_C	Total capacitive charge	V_R = 400 V		—	798	—	nC
C	Total capacitance	f = 1 MHz, V_R = 200 V		—	1488	—	pF
		f = 1 MHz, V_R = 400 V		—	1296	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.167	°C/W

1.3 Thermal and Package Characteristics

The following table shows the package characteristics of the MSCSM70AM025CT6LIAG 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 shows the temperature sensor NTC (see APT0406) of the MSCSM70AM025CT6LIAG 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

1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM70AM025CT6LIAG device.

Figure 1-1. Maximum Thermal Impedance

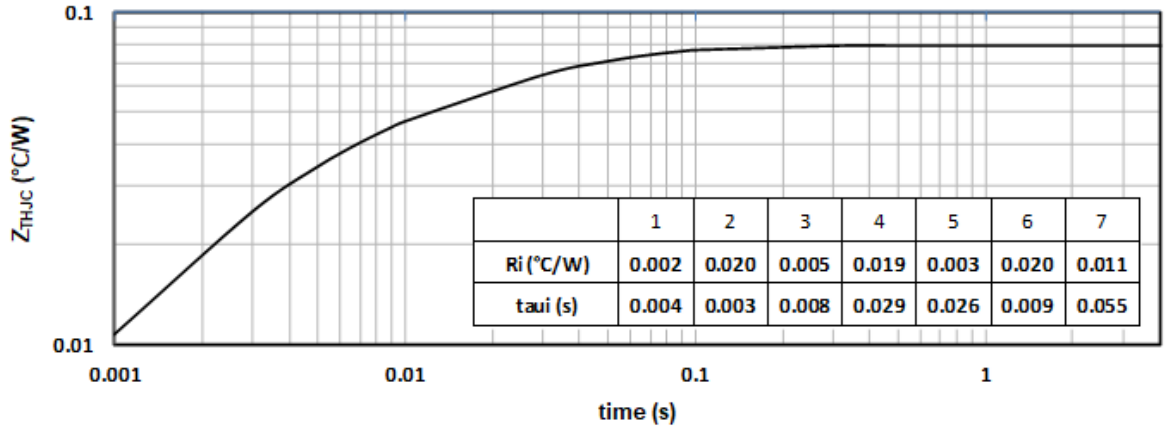


Figure 1-2. Output Characteristics, T_J = 25 °C

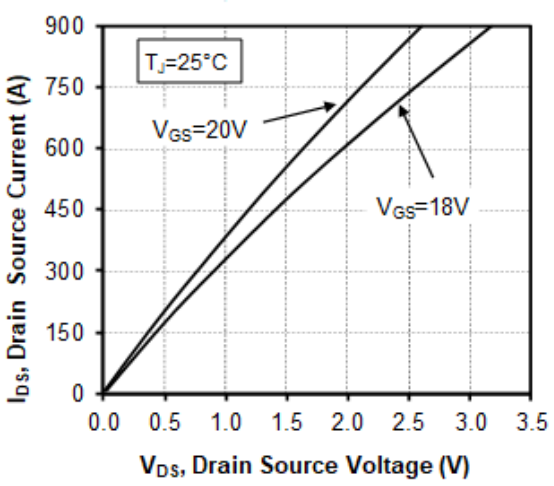


Figure 1-3. Output Characteristics, T_J = 175 °C

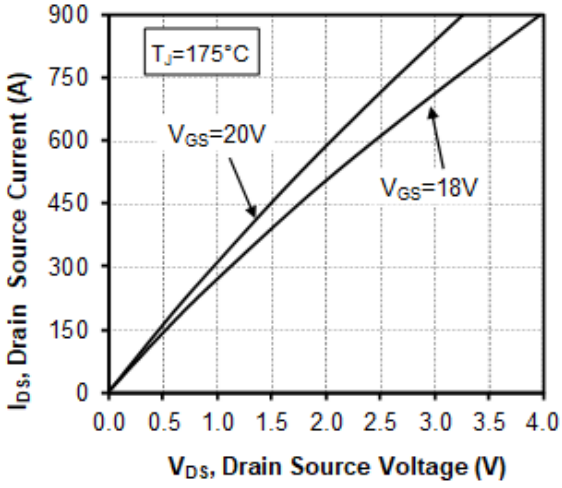


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

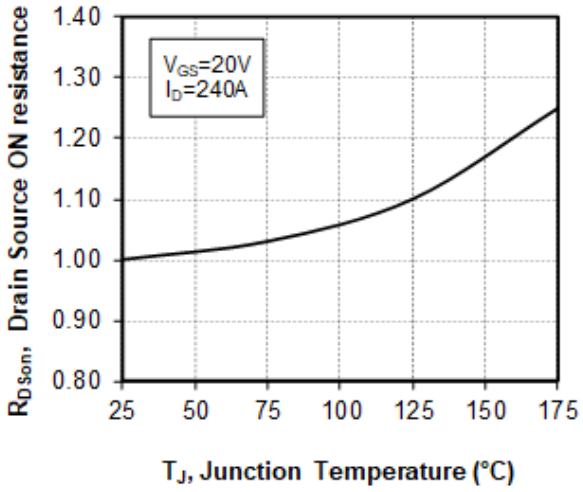


Figure 1-5. Transfer Characteristics

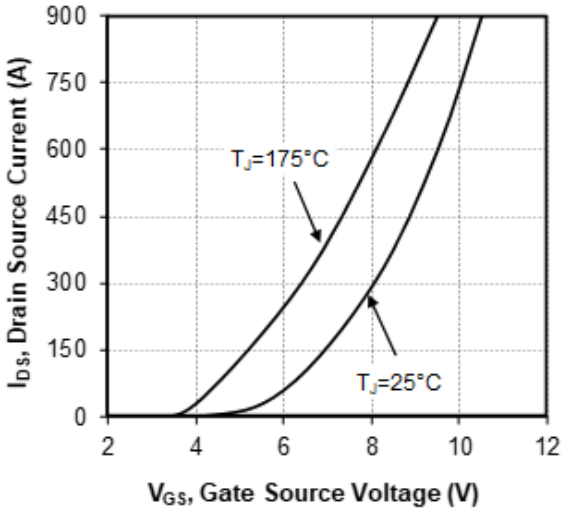


Figure 1-6. Capacitance vs. Drain Source Voltage

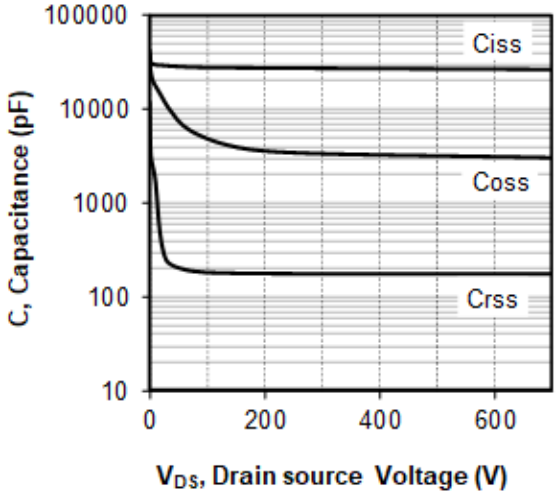


Figure 1-7. Gate Charge vs. Gate Source Voltage

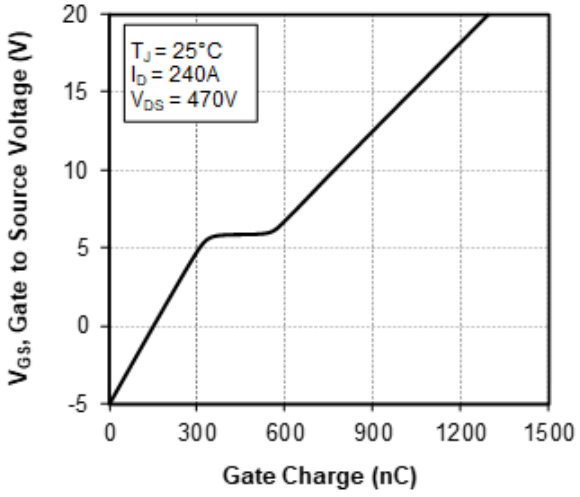


Figure 1-8. Body Diode Characteristics, T_J = 25 °C

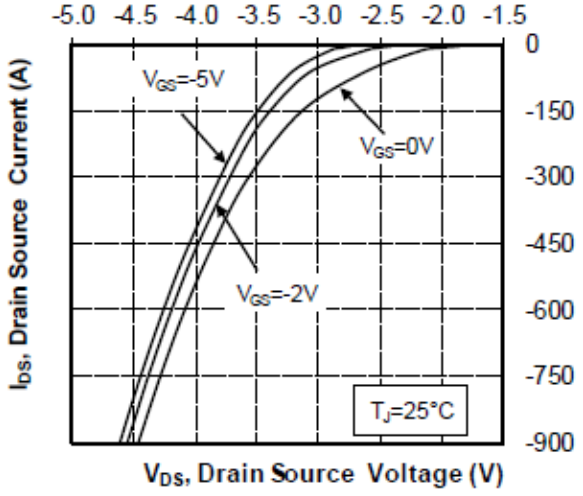


Figure 1-9. 3rd Quadrant Characteristics, T_J = 25 °C

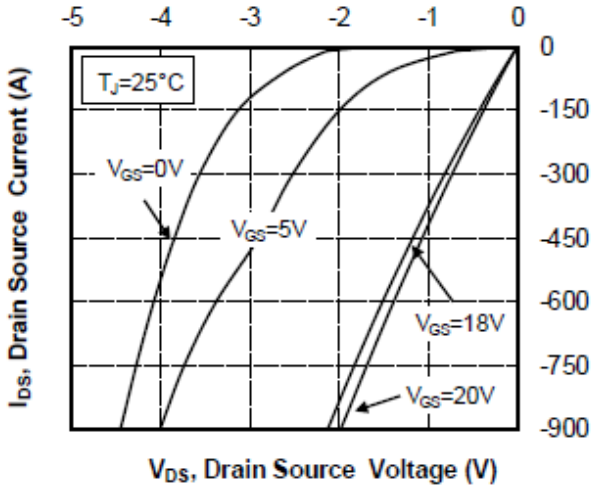


Figure 1-10. Body Diode Characteristics, T_J = 175 °C

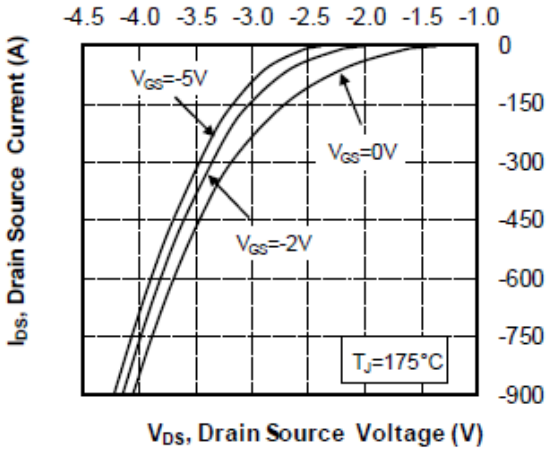


Figure 1-11. 3rd Quadrant Characteristics, T_J = 175 °C

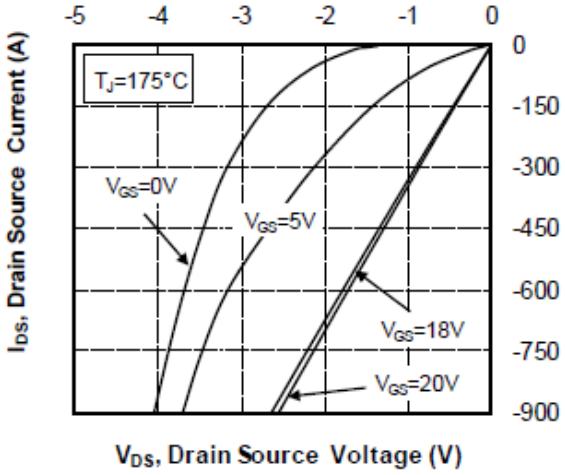


Figure 1-12. Switching Energy vs. Current

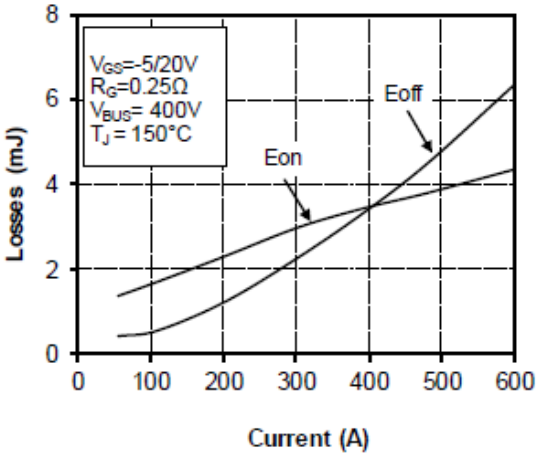


Figure 1-13. Turn On Energy vs. Rg

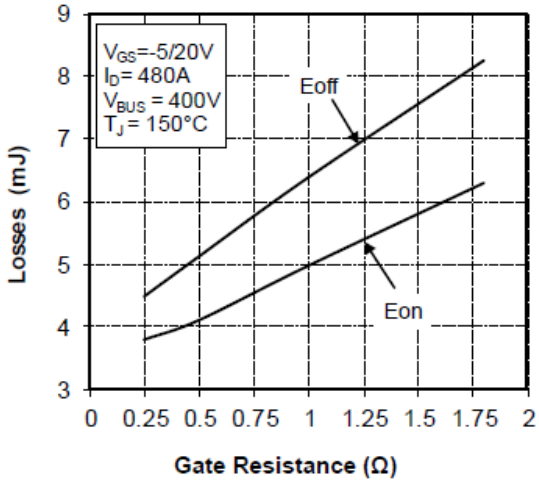
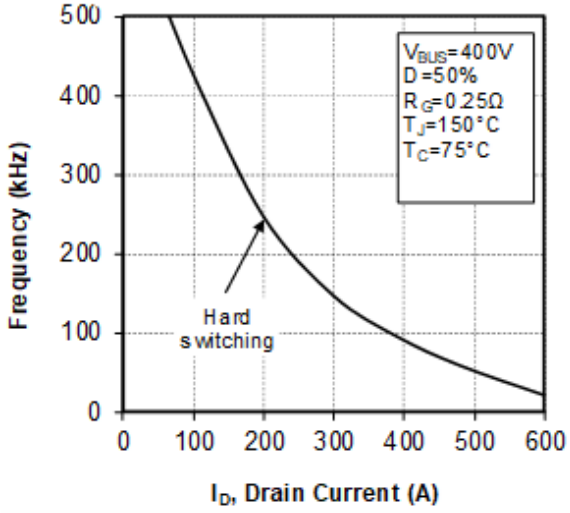


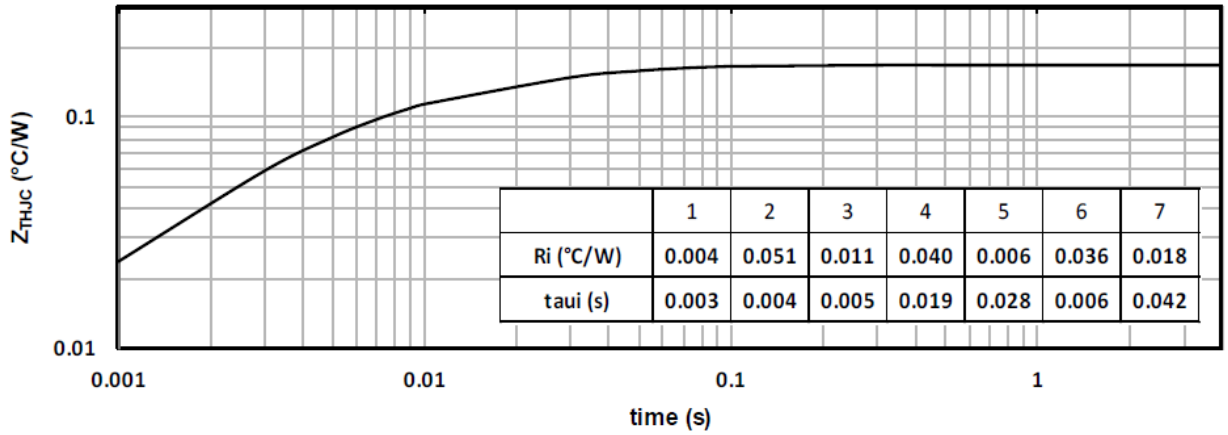
Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curves

The following figures show the SiC diode performance curves of the MSCSM70AM025CT6LIAG device.

Figure 1-15. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.004	0.051	0.011	0.040	0.006	0.036	0.018
taui (s)	0.003	0.004	0.005	0.019	0.028	0.006	0.042

Figure 1-16. Forward Characteristics

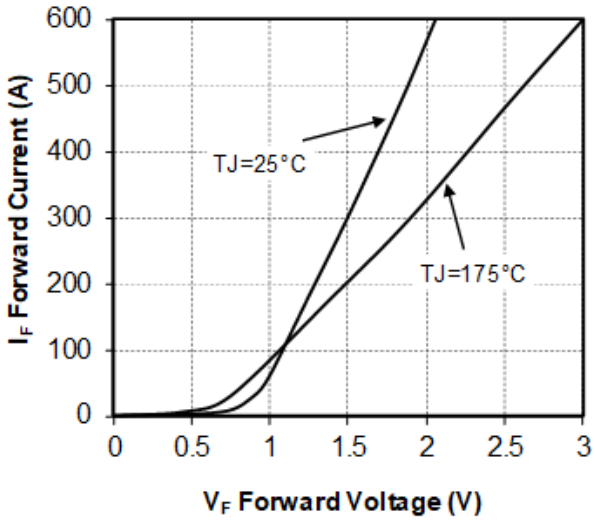
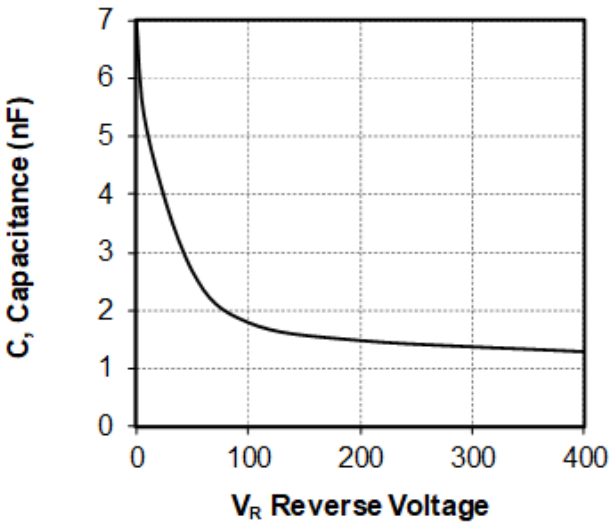


Figure 1-17. Capacitance vs. Reverse Voltage



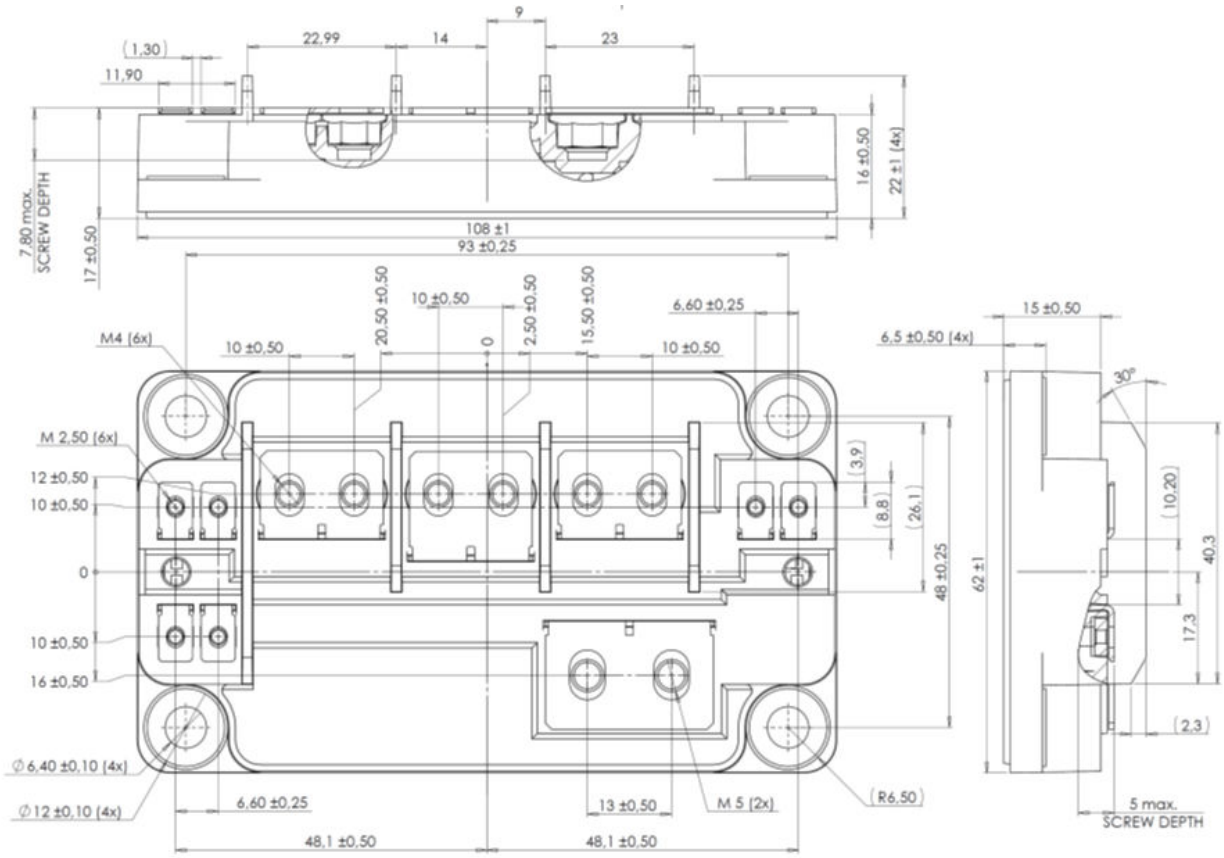
2. Package Specifications

The following section shows the package specification of the MSCSM70AM025CT6LIAG device.

2.1 Package Outline Drawing

The following figure shows the package outline drawing of the MSCSM70AM025CT6LIAG 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.

3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
A	07/2020	This is the first publication of this document.

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