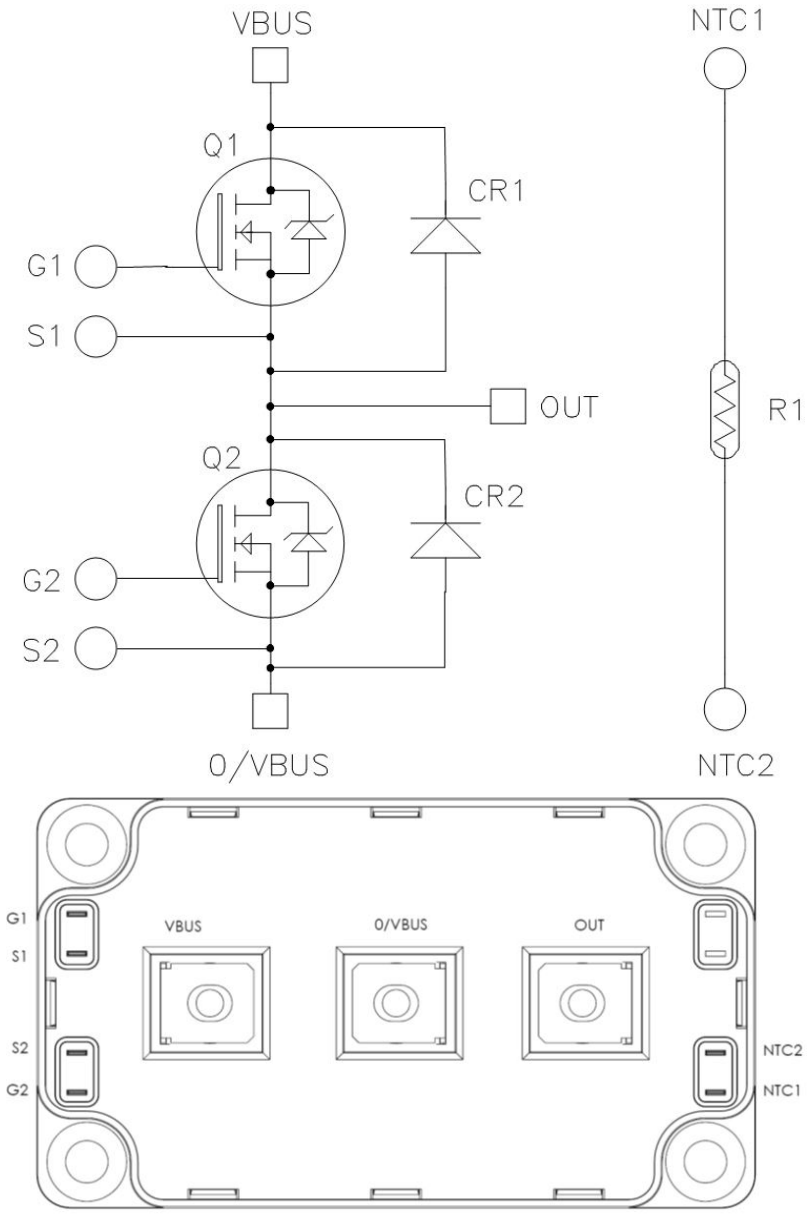
MSCSM70AM025CT6AG

Phase Leg SiC Power Module

Product Overview

The MSCSM70AM025CT6AG device is a phase leg 700 V, 689 A 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 key features of the MSCSM70AM025CT6AG device:

- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF
- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum nitride (AIN) substrate for improved thermal performance

Benefits

The following are benefits of the MSCSM70AM025CT6AG device:

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

Application

The MSCSM70AM025CT6AG 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 MSCSM70AM025CT6AG device.

1.1 SiC MOSFET Characteristics

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70AM025CT6AG device.

Table 1-1. Absolute Maximum Ratings per SiC MOSFET

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	548[1]	
I_{DM}	Pulsed drain current		1380	
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 SiC MOSFET device but output current must be limited due to size of power connectors.

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM70AM025CT6AG device.

Table 1-2. Electrical Characteristics per SiC MOSFET

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V; V_{DS} = 700 V		—	—	600	µA
$R_{DS(on)}$	Drain–Source on resistance	V_{GS} = 20 V	T_J = 25 °C	—	2.5	3.2	mΩ
		I_D = 240 A	T_J = 175 °C		3.2	—	
$V_{GS(th)}$	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		—	—	600	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70AM025CT6AG device.

Table 1-3. Dynamic Characteristics per SiC MOSFET

Symbol	Characteristics	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	V_{GS} = –5 V/20 V		—	78	—	ns
T_r	Rise time	V_{Bus} = 400 V		—	125	—	
$T_{d(off)}$	Turn-off delay time	I_D = 480 A; T_J = 150 °C		—	214	—	
T_f	Fall time	$R_{G(ON)}$ = 4.7 Ω; $R_{G(OFF)}$ = 2.7 Ω		—	92	—	
E_{on}	Turn-on energy	V_{GS} = –5/20 V	T_J = 150 °C	—	6.1	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400 V I_D = 480 A $R_{G(ON)}$ = 4.7 Ω $R_{G(OFF)}$ = 2.7 Ω	T_J = 150 °C	—	10.5	—	mJ
R_{Gint}	Internal gate resistance			—	0.95	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.08	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM70AM025CT6AG device.

Table 1-4. Body Diode Ratings and Characteristics per SiC MOSFET

Symbol	Characteristics	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 V_R = 400 V; di_F/dt = 6000 A/µs	—	40	—	ns
Q_{rr}	Reverse recovery charge		—	1.9	—	µC
I_{rr}	Reverse recovery current		—	89	—	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 MSCSM70AM025CT6AG device.

Table 1-5. SiC Schottky Diode Ratings and Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	700	V
I_{RRM}	Reverse leakage current	V_R=700 V	T_J = 25 °C	—	90	1200	µA
			T_J = 175 °C	—	1500	—	
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 lists the thermal and package characteristics of MSCSM70AM025CT6AG device.

Table 1-6. Thermal and Package Characteristics

Symbol	Characteristics			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 temperature range			–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

1.4 Temperature Sensor NTC

The following table lists the temperature sensor NTC. See *APT0406 Application Note* for more information.

Table 1-7. Temperature Sensor NTC

Symbol	Characteristics		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	—	%

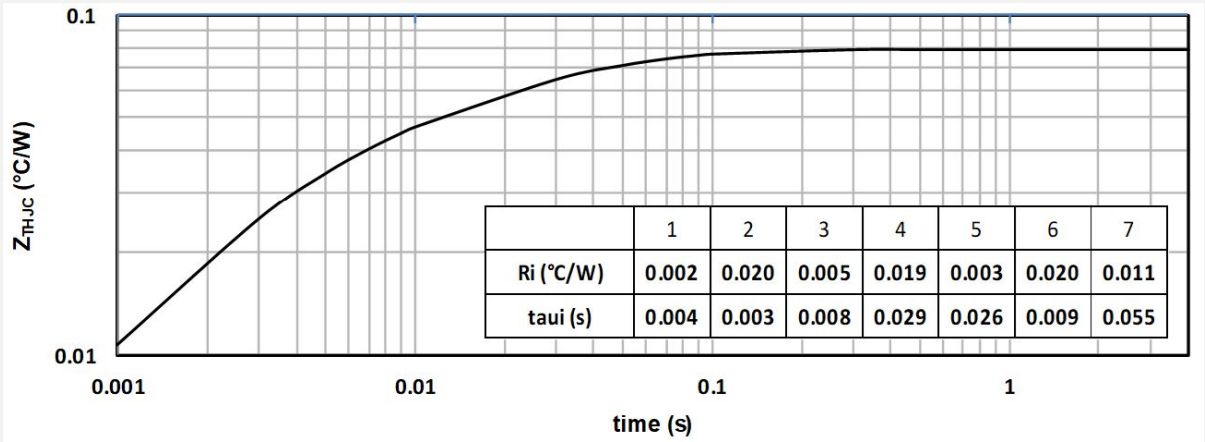
$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

T: Thermistor temperature
R_T: Thermistor value at T

2. Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70AM025CT6AG device.

Figure 2-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.020	0.005	0.019	0.003	0.020	0.011
taui (s)	0.004	0.003	0.008	0.029	0.026	0.009	0.055

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

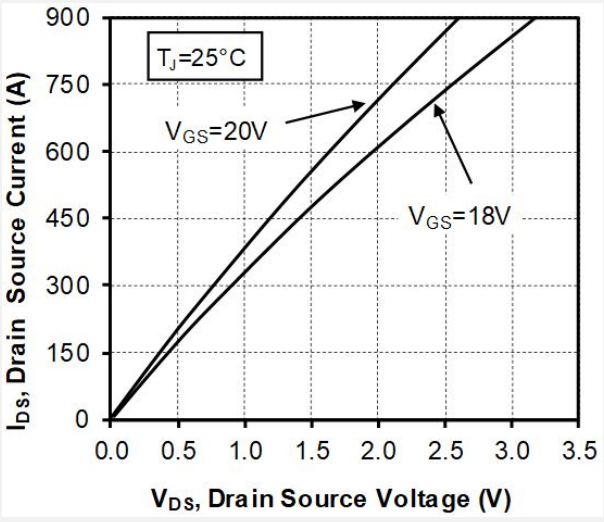


Figure 2-3. Output Characteristics, T_J = 175 °C

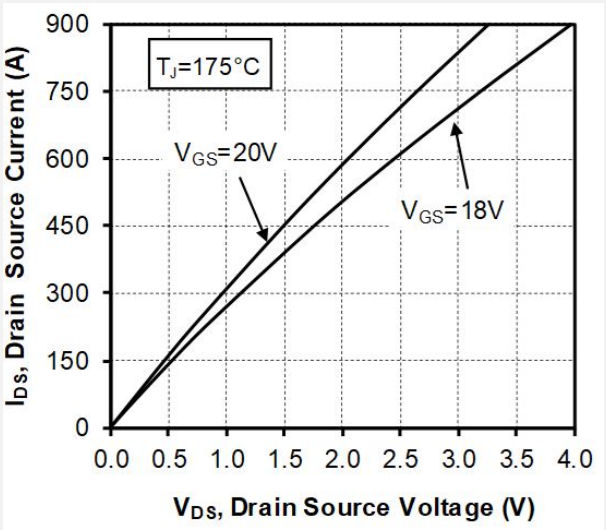


Figure 2-4. Normalized $R_{DS(on)}$ vs. Temperature

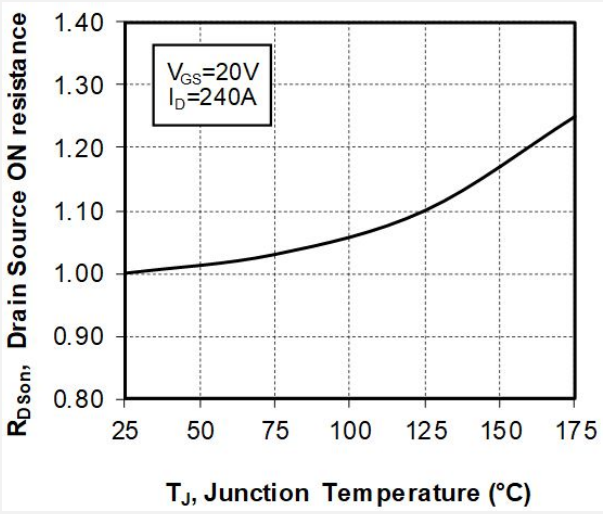


Figure 2-5. Transfer Characteristics

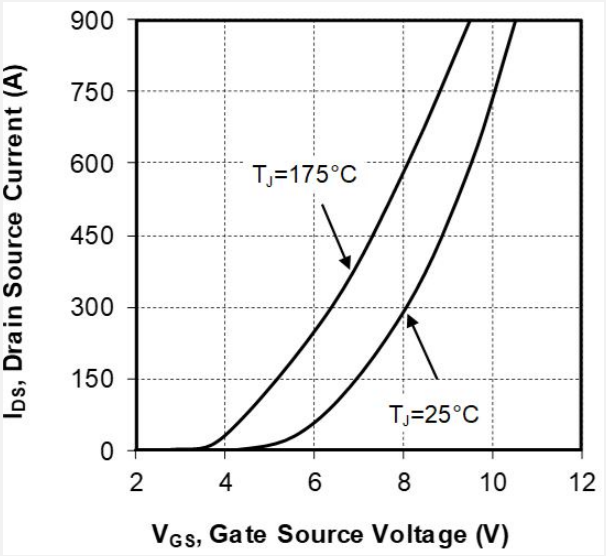


Figure 2-6. Capacitance vs. Drain Source Voltage

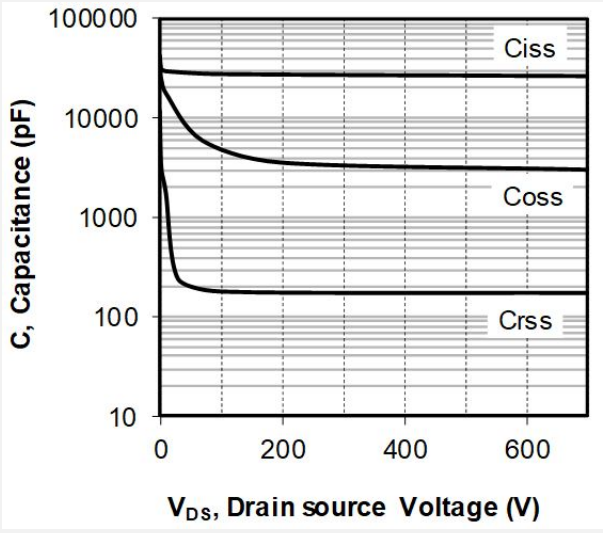


Figure 2-7. Gate Charge vs. Gate Source Voltage

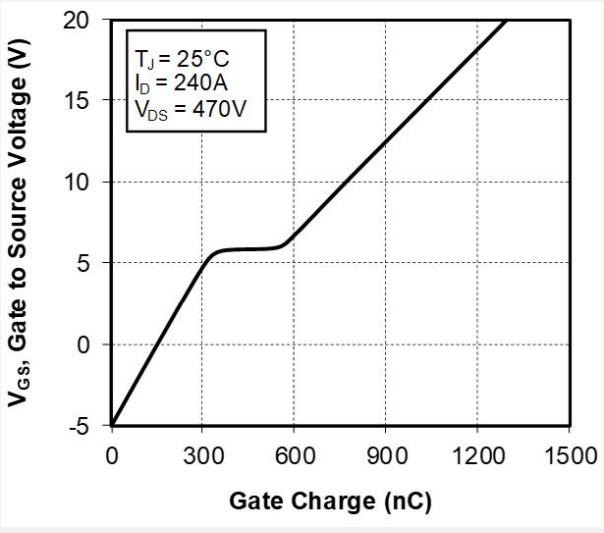


Figure 2-8. Body Diode Characteristics, T_J = 25 °C

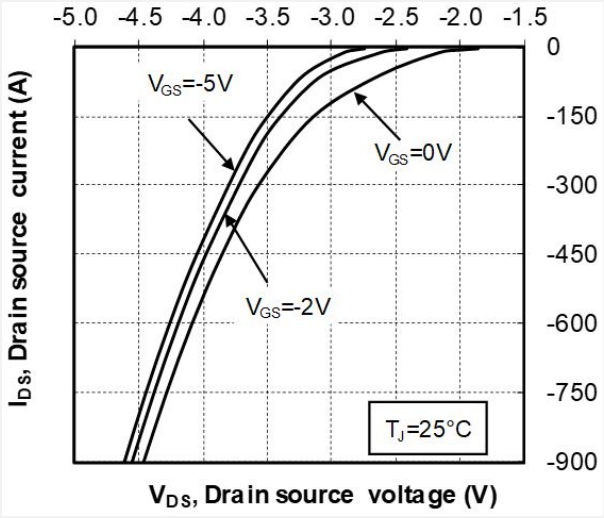


Figure 2-9. 3rd Quadrant Characteristics, T_J = 25 °C

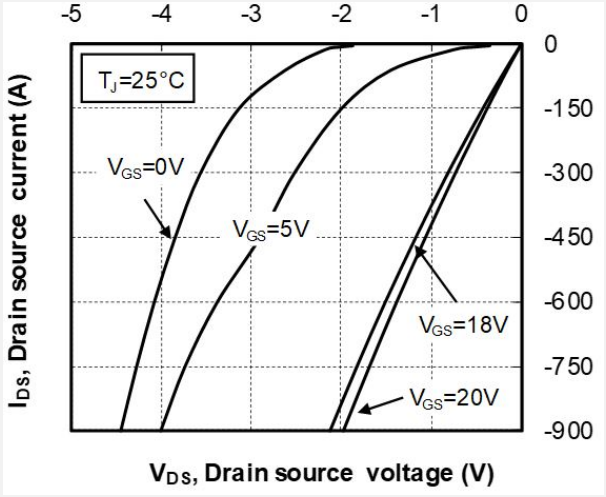


Figure 2-10. Body Diode Characteristics, T_J = 175 °C

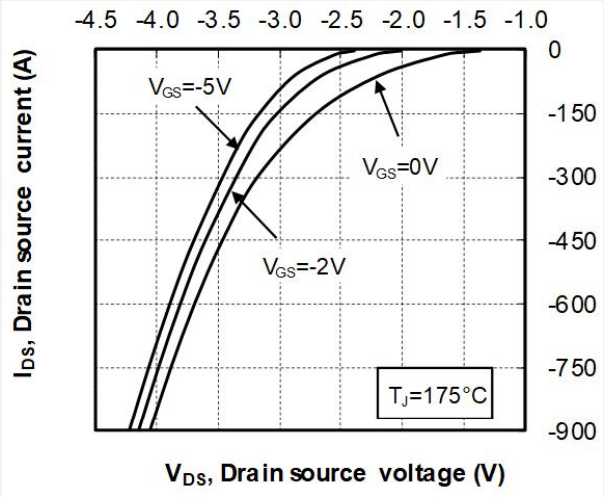


Figure 2-11. 3rd Quadrant Characteristics, T_J = 175 °C

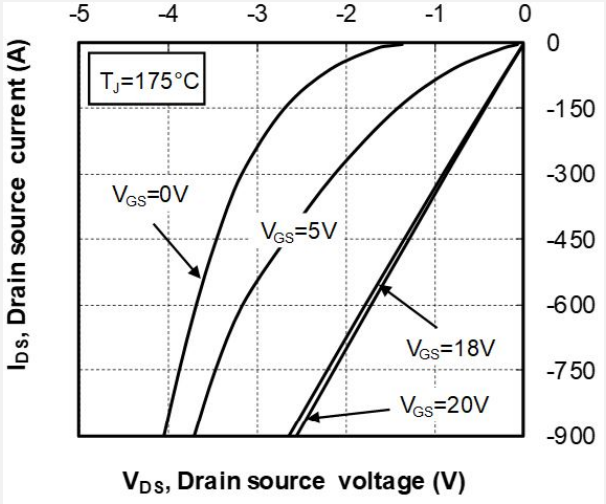


Figure 2-12. Switching Energy vs. Current

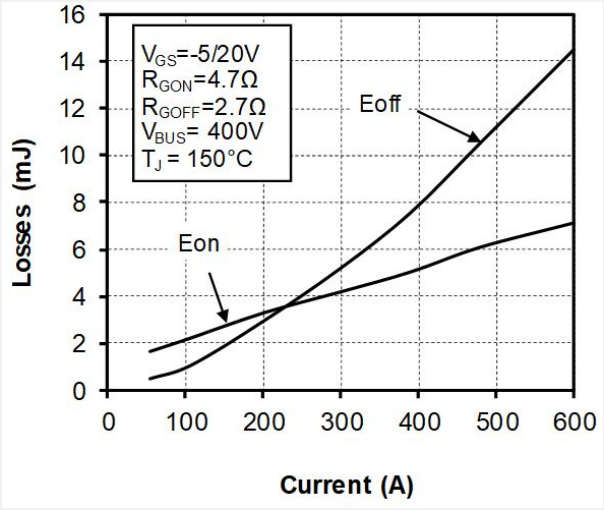


Figure 2-13. Turn On Energy vs. Rg

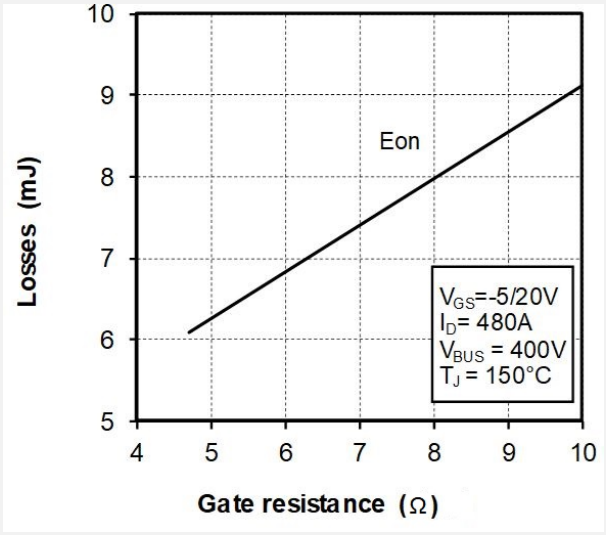


Figure 2-14. Turn Off Energy vs. Rg

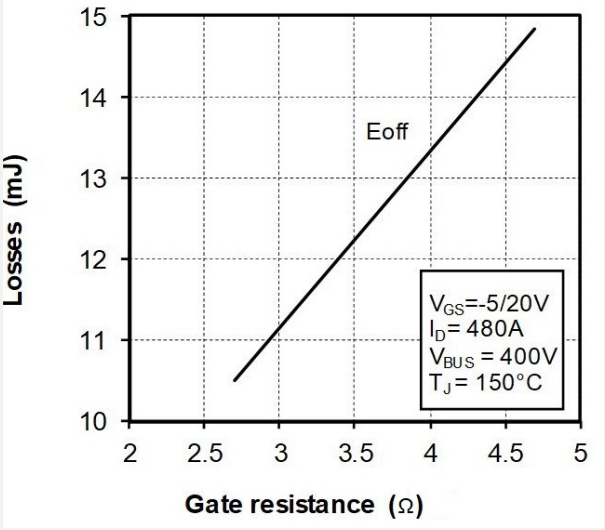
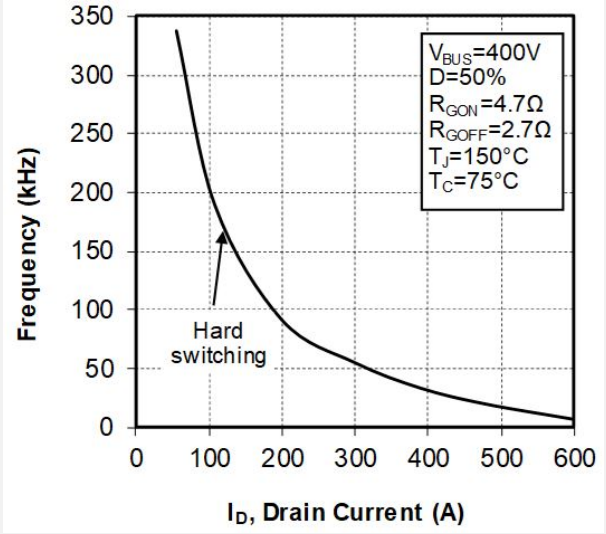


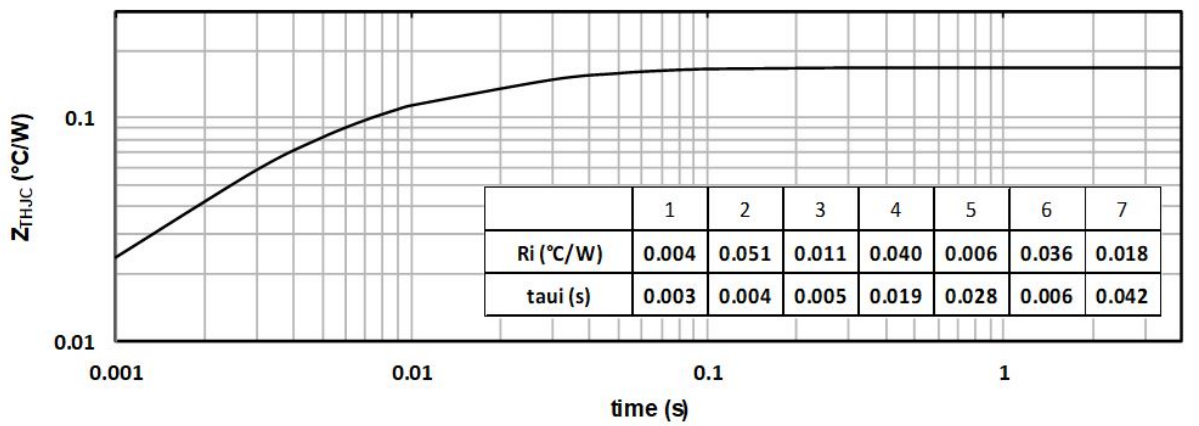
Figure 2-15. Operating Frequency vs. Drain Current



3. Typical SiC Diode Performance Curve

This section shows the typical SiC diode performance curves of MSCSM70AM025CT6AG device.

Figure 3-1. 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 3-2. Forward Characteristics

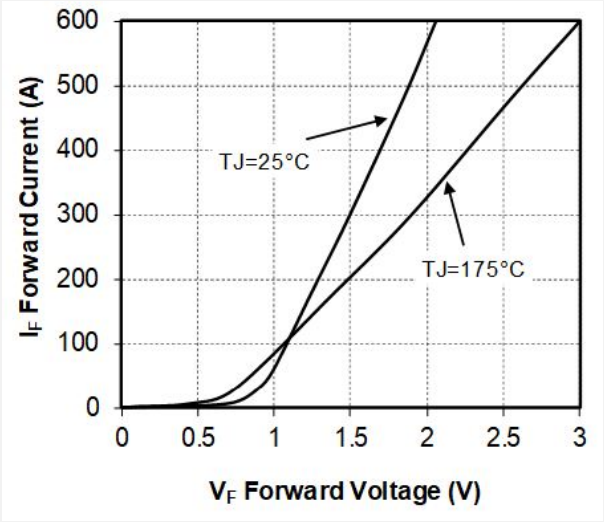
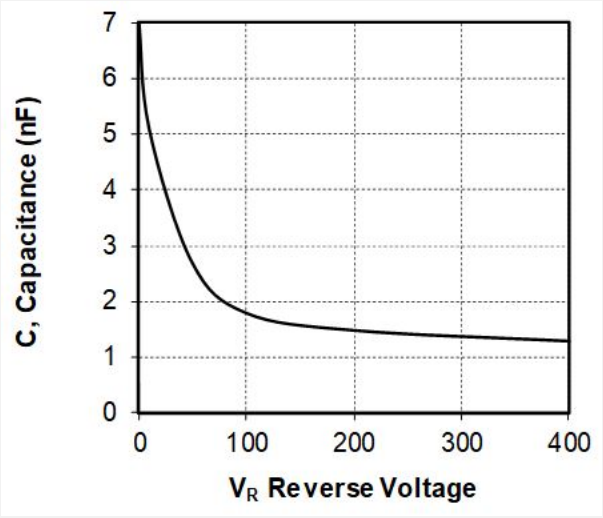


Figure 3-3. Capacitance vs. Reverse Voltage



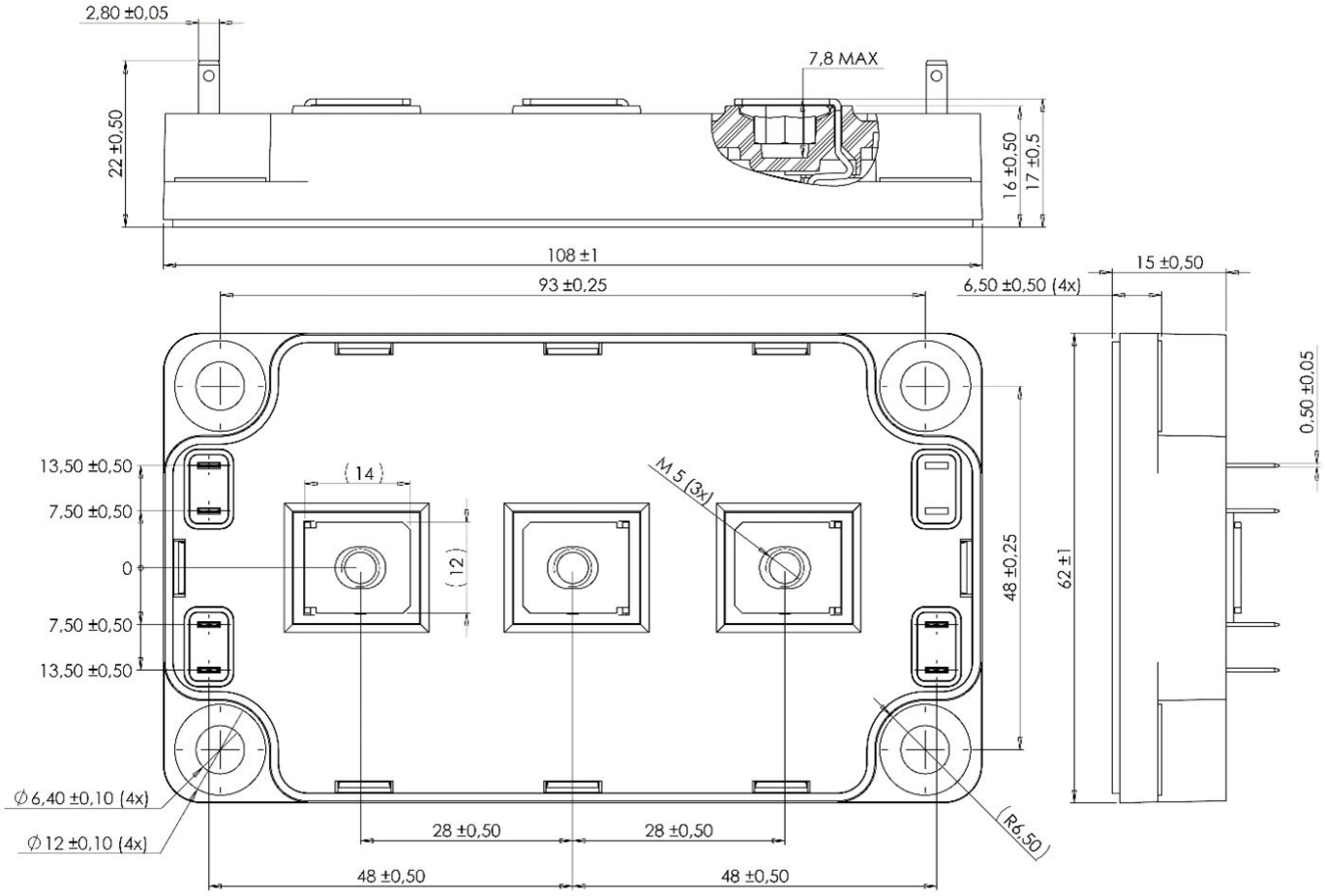
4. Package Specifications

The following section shows the package specification of MSCSM70AM025CT6AG device.

4.1 Package Outline

The following figure shows the package outline drawing of MSCSM70AM025CT6AG device. The dimensions are in millimeters. See *Application Note APT0601*—Mounting instructions for SP6 power modules for more information.

Figure 4-1. Package Outline Drawing



5. Revision History

Revision	Date	Description
A	11/2020	Revision A is the latest publication of this document. The following is the summary of changes: • The document was updated to Microchip template. • Document ID is changed to DS00003749.

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