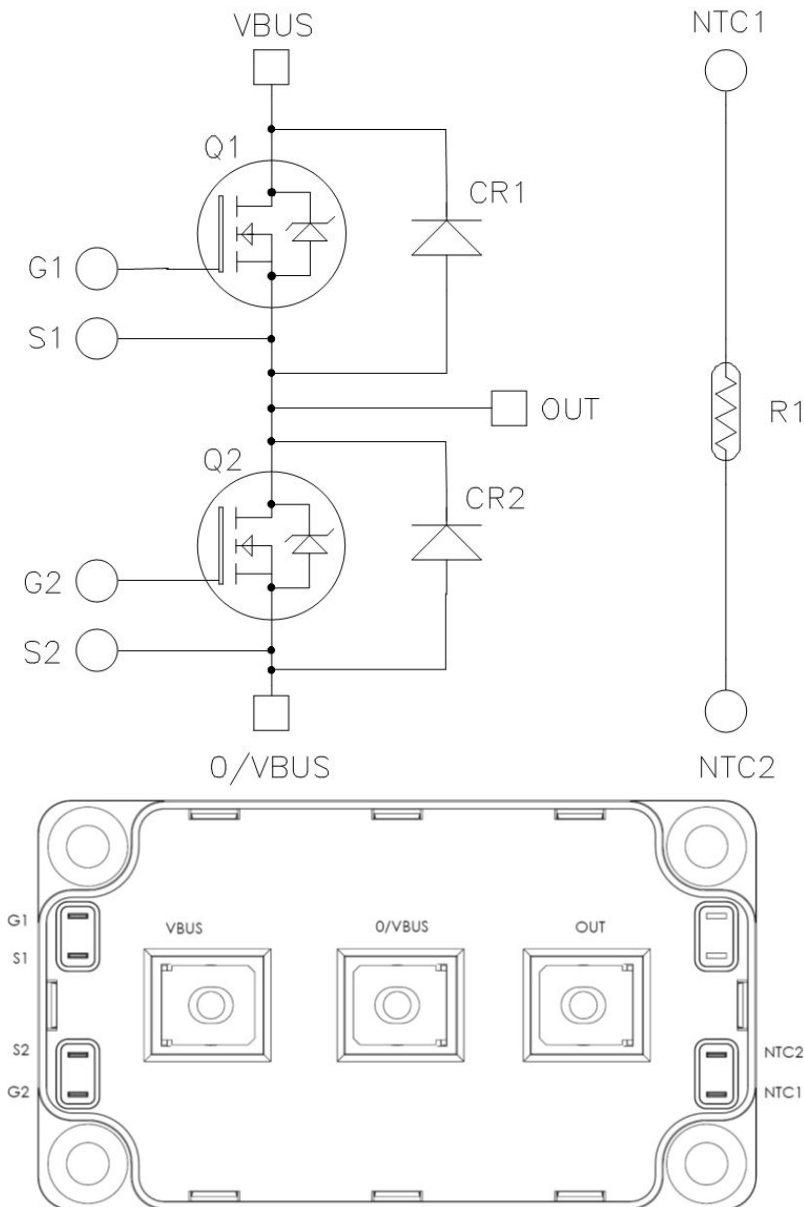


Phase Leg SiC Power Module

Product Overview

The MSCSM70AM025CT6AG device is a phase leg 700 V, 689 A silicon carbide (SiC) power module.



All ratings at $T_J = 25\text{ }^\circ\text{C}$, 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 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 (AlN) 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	$T_C = 25\text{ }^\circ\text{C}$	689 ¹
		$T_C = 80\text{ }^\circ\text{C}$	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	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	1882

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	$V_{GS} = 0\text{ V}; V_{DS} = 700\text{ V}$	—	—	600	μA	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 240\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	2.5	3.2	m Ω
			$T_J = 175\text{ }^\circ\text{C}$	—	3.2	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}, I_D = 24\text{ mA}$	1.9	2.4	—	V	
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$	—	—	600	nA	

MSCSM70AM025CT6AG

Electrical Specifications

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	$V_{GS} = 0\text{ V}$	—	27	—	nF
C_{oss}	Output capacitance	$V_{DS} = 700\text{ V}$	—	3	—	
C_{rss}	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.17	—	
Q_g	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$	—	1290	—	nC
Q_{gs}	Gate–Source charge	$V_{Bus} = 470\text{ V}$	—	348	—	
Q_{gd}	Gate–Drain charge	$I_D = 240\text{ A}$	—	210	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5\text{ V}/20\text{ V}$	—	78	—	ns
T_r	Rise time	$V_{Bus} = 400\text{ V}$	—	125	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 480\text{ A}; T_J = 150\text{ °C}$	—	214	—	
T_f	Fall time	$R_{G(ON)} = 4.7\text{ }\Omega; R_{G(OFF)} = 2.7\text{ }\Omega$	—	92	—	
E_{on}	Turn-on energy	$V_{GS} = -5/20\text{ V}$	—	6.1	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 400\text{ V}$ $I_D = 480\text{ A}$ $R_{G(ON)} = 4.7\text{ }\Omega$ $R_{G(OFF)} = 2.7\text{ }\Omega$				
R_{Gint}	Internal gate resistance		—	0.95	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.08	$^{\circ}\text{C}/\text{W}$

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	$V_{GS} = 0\text{ V}; I_{SD} = 240\text{ A}$	—	3.4	—	V
		$V_{GS} = -5\text{ V}; I_{SD} = 240\text{ A}$	—	3.8	—	
t_{rr}	Reverse recovery time	$I_{SD} = 240\text{ A}; V_{GS} = -5\text{ V}$ $V_R = 400\text{ V}; di_F/dt = 6000\text{ A}/\mu\text{s}$	—	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	$V_R=700\text{ V}$	$T_J = 25\text{ }^\circ\text{C}$	—	90	1200	μA
			$T_J = 175\text{ }^\circ\text{C}$	—	1500	—	
I_F	DC forward current	—	$T_C = 65\text{ }^\circ\text{C}$	—	300	—	A
V_F	Diode forward voltage	$I_F = 300\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	1.9	—	
Q_C	Total capacitive charge	$V_R = 400\text{ V}$	—	—	798	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 200\text{ V}$		—	1488	—	pF
		$f = 1\text{ MHz}, V_R = 400\text{ V}$		—	1296	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.167	$^\circ\text{C/W}$

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		
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
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

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

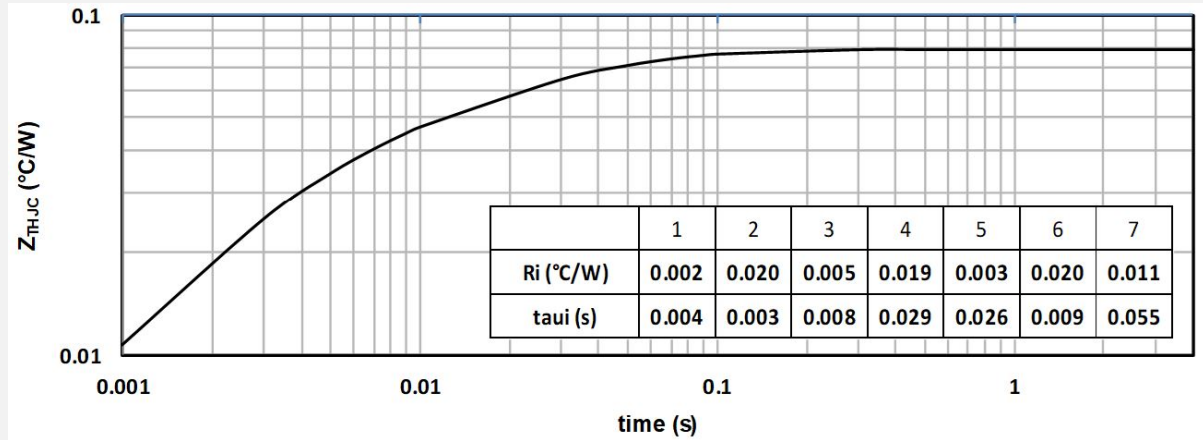


Figure 2-2. Output Characteristics, $T_J = 25^\circ\text{C}$

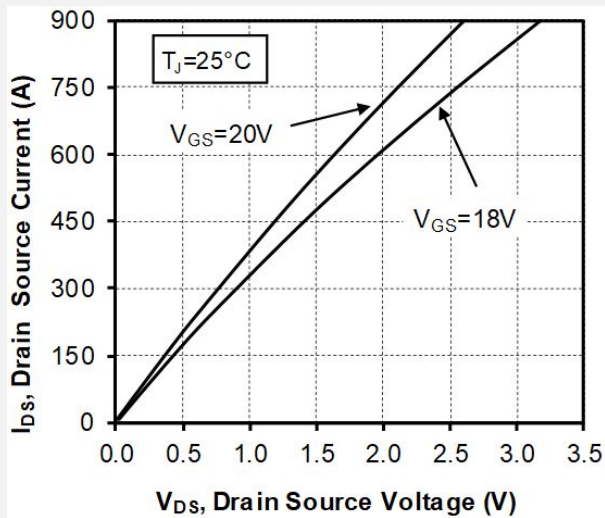
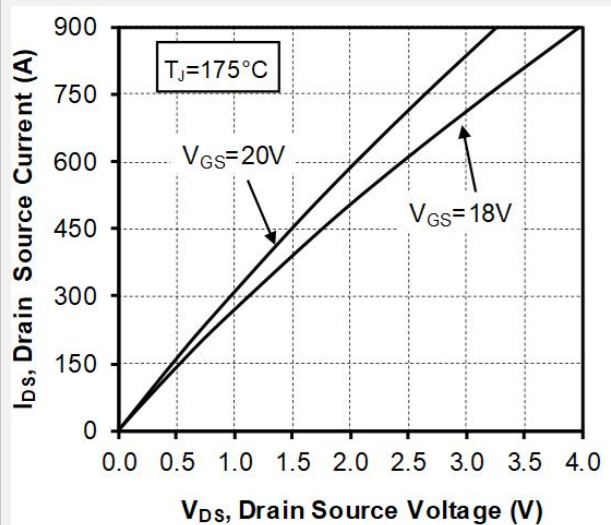


Figure 2-3. Output Characteristics, $T_J = 175^\circ\text{C}$



MSCSM70AM025CT6AG

Typical SiC MOSFET Performance Curve

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

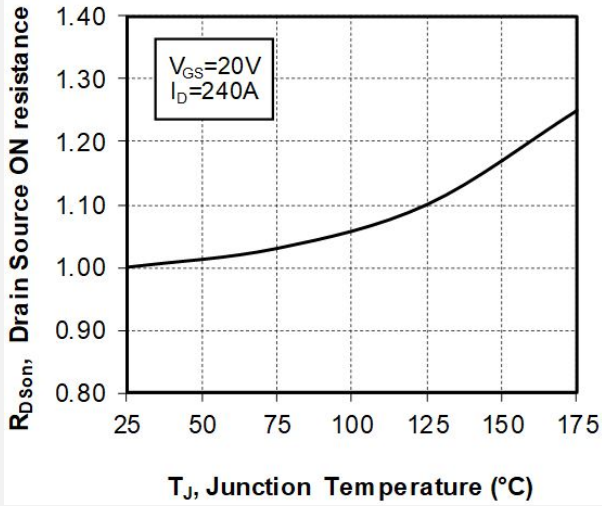


Figure 2-5. Transfer Characteristics

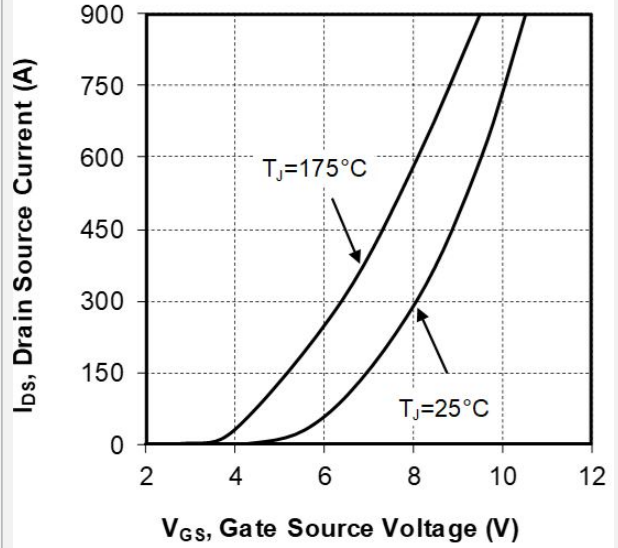


Figure 2-6. Capacitance vs. Drain Source Voltage

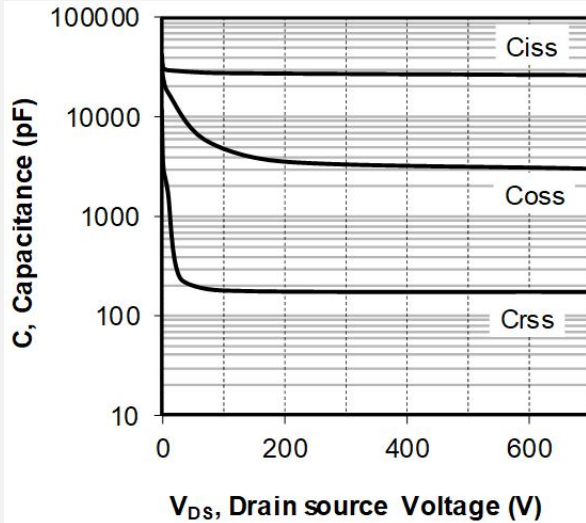
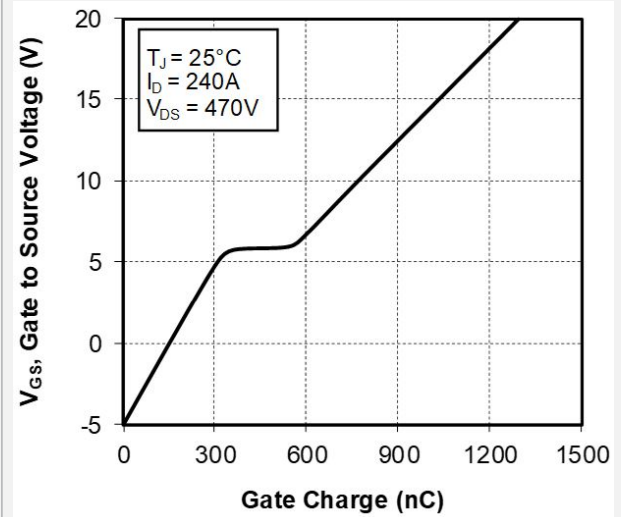


Figure 2-7. Gate Charge vs. Gate Source Voltage



MSCSM70AM025CT6AG

Typical SiC MOSFET Performance Curve

Figure 2-8. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

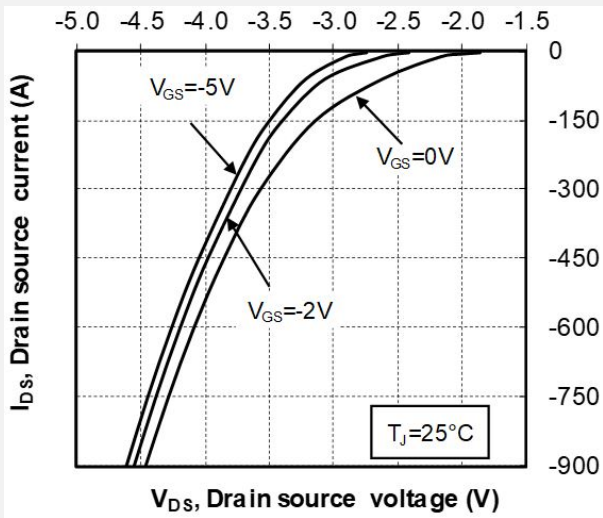


Figure 2-9. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

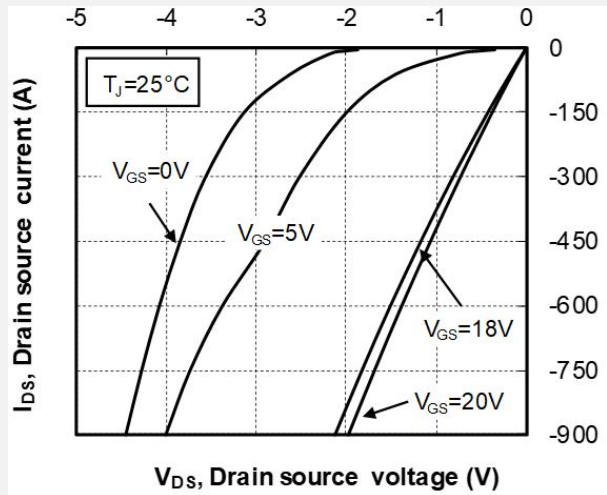


Figure 2-10. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

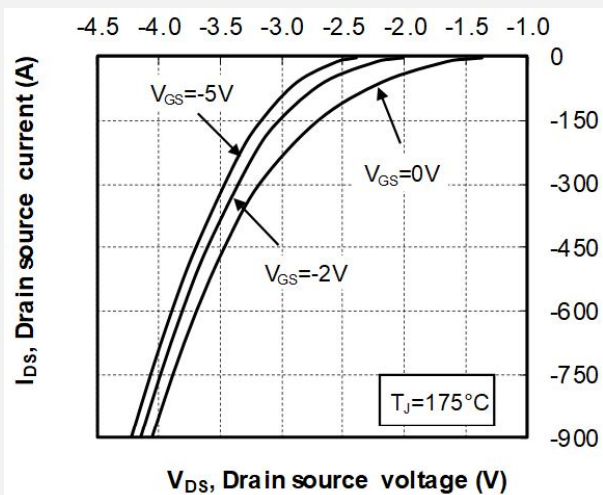
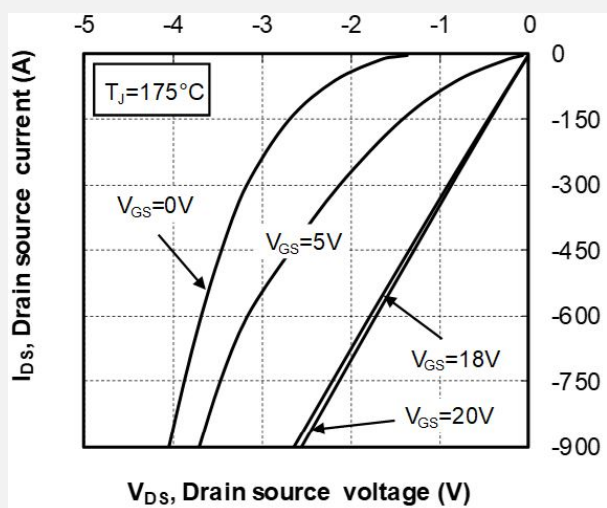


Figure 2-11. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$



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Typical SiC MOSFET Performance Curve

Figure 2-12. Switching Energy vs. Current

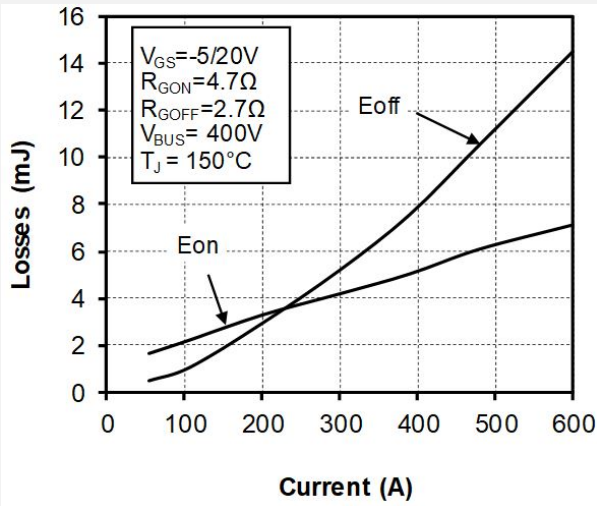


Figure 2-13. Turn On Energy vs. Rg

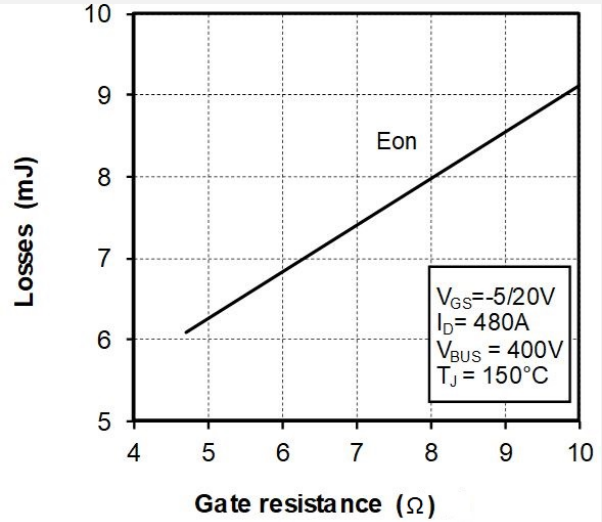


Figure 2-14. Turn Off Energy vs. Rg

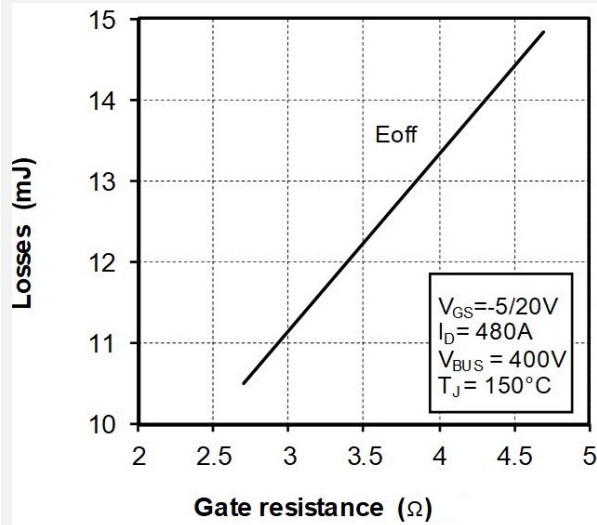
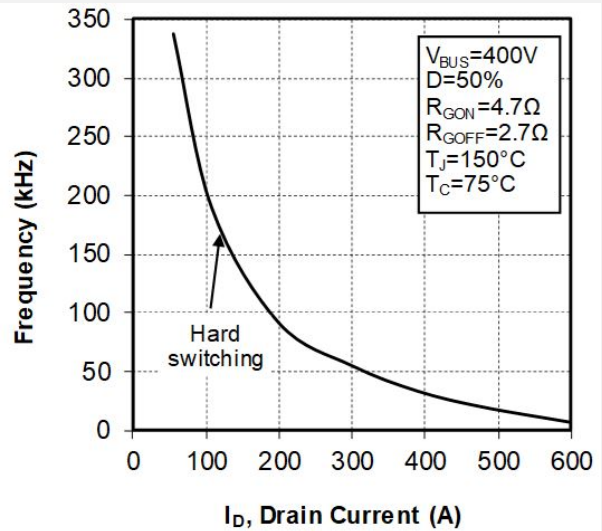


Figure 2-15. Operating Frequency vs. Drain Current



3. Typical SiC Diode Performance Curve

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

Figure 3-1. Maximum Thermal Impedance

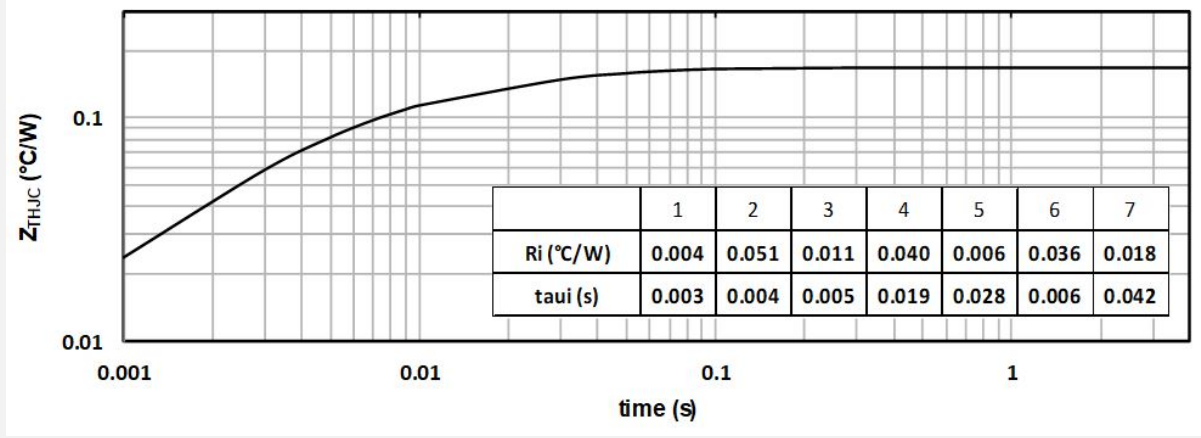


Figure 3-2. Forward Characteristics

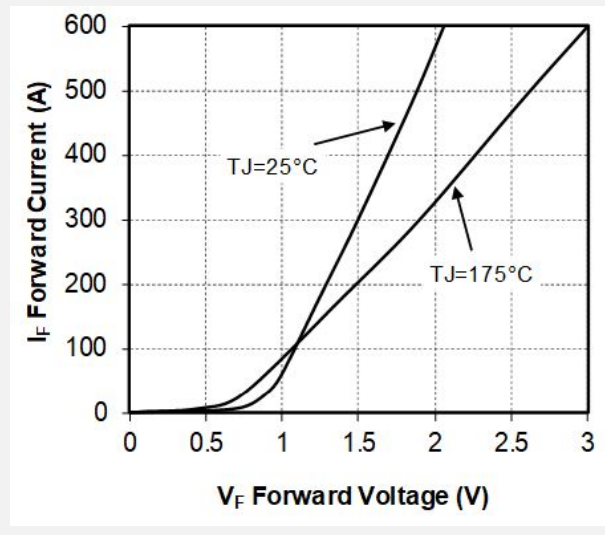
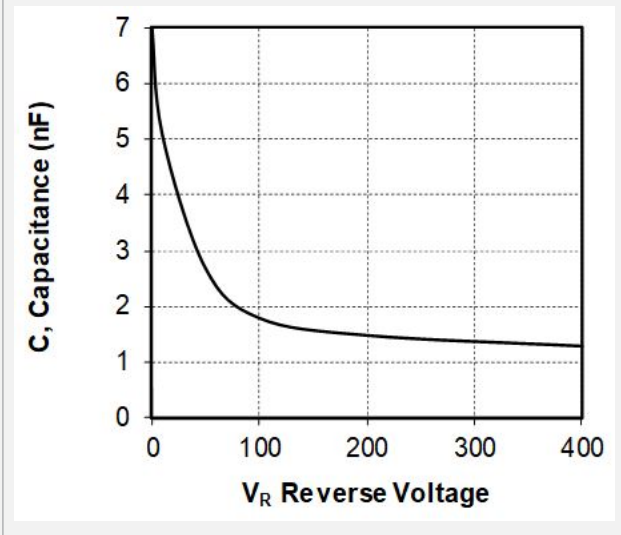


Figure 3-3. Capacitance vs. Reverse Voltage



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: <ul style="list-style-type: none"><li data-bbox="657 407 1227 434">• The document was updated to Microchip template.<li data-bbox="657 441 1133 468">• Document ID is changed to DS00003749.

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