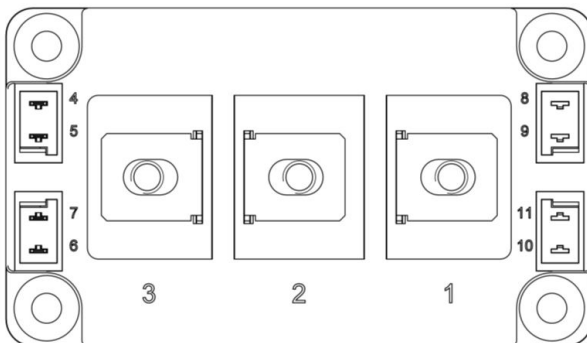
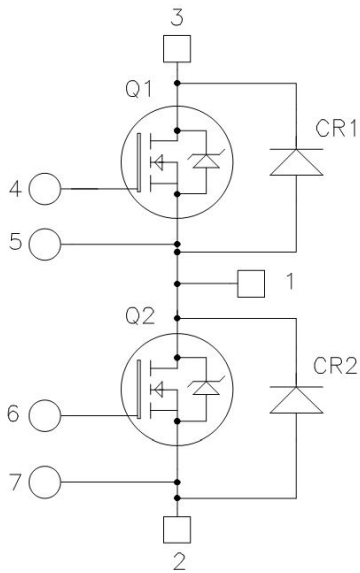


Phase Leg SiC Power Module

Product Overview

The MSCSM70AM025CD3AG device is a phase leg 700 V, 689 A silicon carbide (SiC) power module.



All ratings at $T_J = 25^\circ\text{C}$, 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 MSCSM70AM025CD3AG 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 emitter for easy drive
- High level of integration
- AlN substrate for improved thermal performance
- M6 power connectors

Benefits

The following are benefits of the MSCSM70AM025CD3AG 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 MSCSM70AM025CD3AG 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 MSCSM70AM025CD3AG device.

1.1 SiC MOSFET Characteristics

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70AM025CD3AG device.

Table 1-1. Absolute Maximum Ratings per SiC MOSFET

Symbol	Parameter		Maximum Ratings	Unit
V_{DS}	Drain-Source voltage		700	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	689 ¹	A
		$T_C = 80\text{ }^{\circ}\text{C}$	548 ¹	
I_{DM}	Pulsed drain current		1380	A
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	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 MSCSM70AM025CD3AG 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

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70AM025CD3AG 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	$V_{GS} = -5\text{ V}/20\text{ V}$	$T_J = 150\text{ °C}$	6.1	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 400\text{ V}$ $I_D = 480\text{ A}$ $R_{G(ON)} = 4.7\text{ }\Omega$ $R_{G(OFF)} = 2.7\text{ }\Omega$	$T_J = 150\text{ °C}$	10.5	—	mJ
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 MSCSM70AM025CD3AG 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 the MSCSM70AM025CD3AG 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	$V_R = 700\text{ V}$	$T_J = 25\text{ °C}$	—	90	1200	μA
			$T_J = 175\text{ °C}$	—	1500	—	
I_F	DC forward current	—	$T_C = 65\text{ °C}$	—	300	—	A
V_F	Diode forward voltage	$I_F = 300\text{ A}$	$T_J = 25\text{ °C}$	—	1.5	1.8	V
			$T_J = 175\text{ °C}$	—	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 MSCSM70AM025CD3AG device.

Table 1-6. Thermal and Package Characteristics

Symbol	Characteristics			Min	Max	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case $t = 1\text{ min}$, 50 Hz/60 Hz			4000	—	V
T_J	Operating junction temperature range			−40	175	$^{\circ}\text{C}$
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

2. Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70AM025CD3AG device.

Figure 2-1. Maximum Thermal Impedance

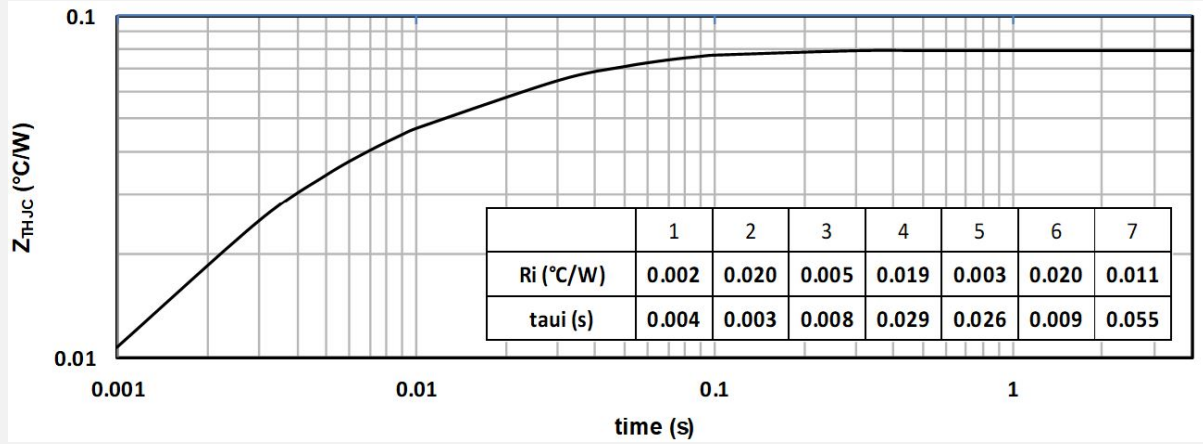


Figure 2-2. Output Characteristics, $T_J = 25^\circ\text{C}$

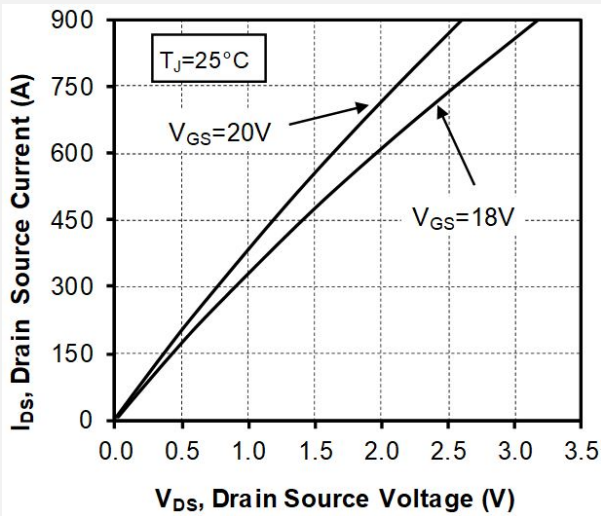
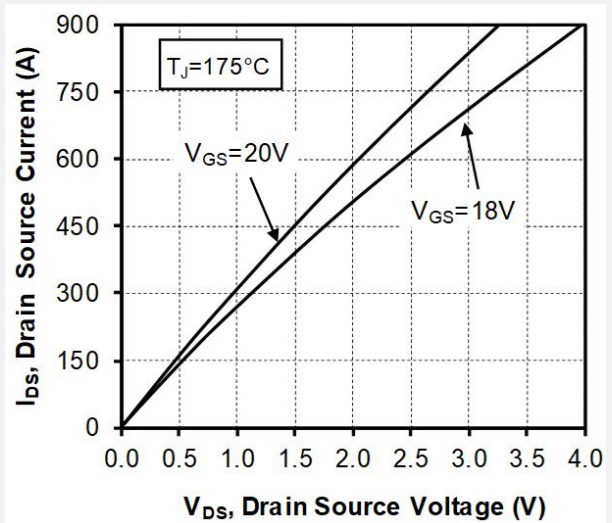


Figure 2-3. Output Characteristics, $T_J = 175^\circ\text{C}$



MSCSM70AM025CD3AG

Typical SiC MOSFET Performance Curve

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

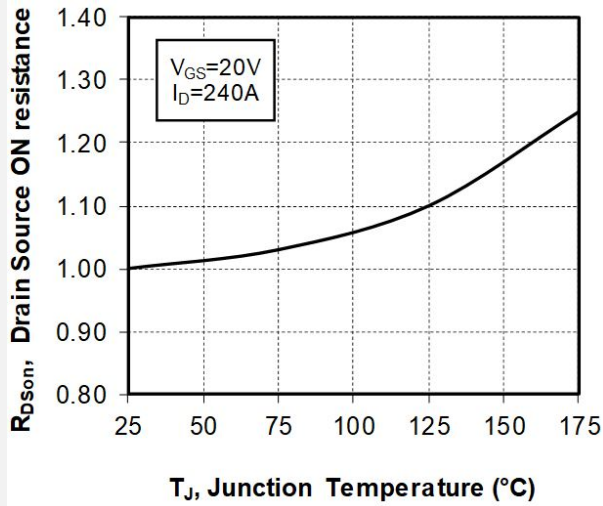


Figure 2-5. Transfer Characteristics

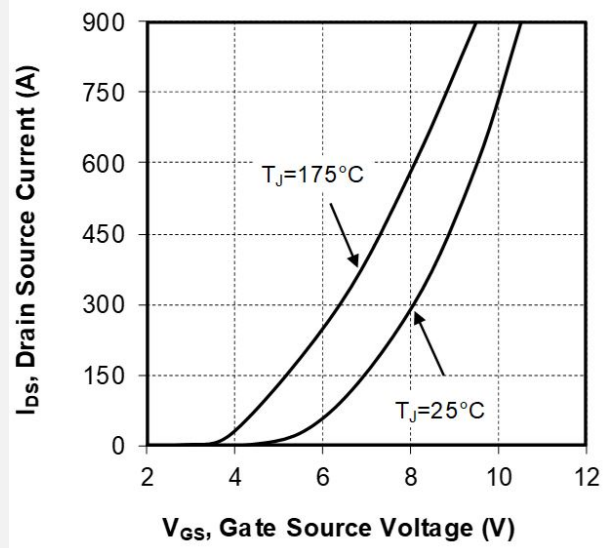


Figure 2-6. Capacitance vs. Drain Source Voltage

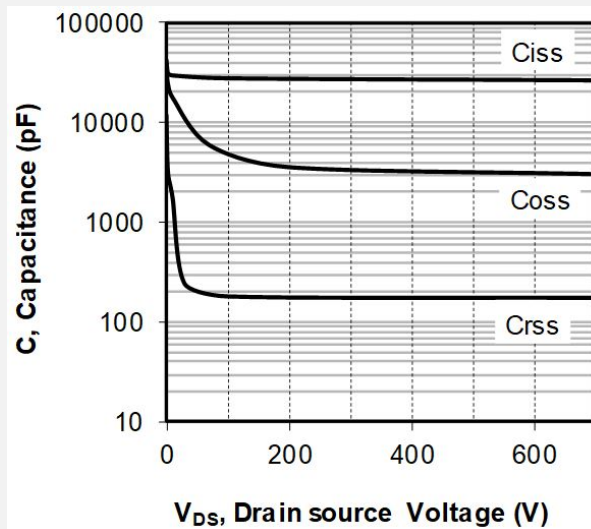
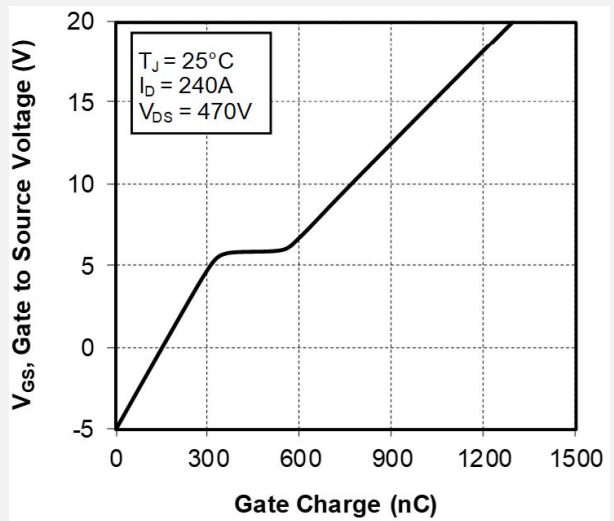


Figure 2-7. Gate Charge vs. Gate Source Voltage



MSCSM70AM025CD3AG

Typical SiC MOSFET Performance Curve

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

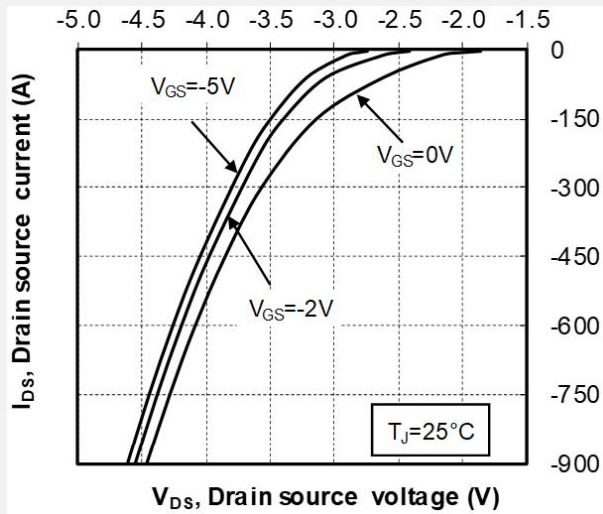


Figure 2-9. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

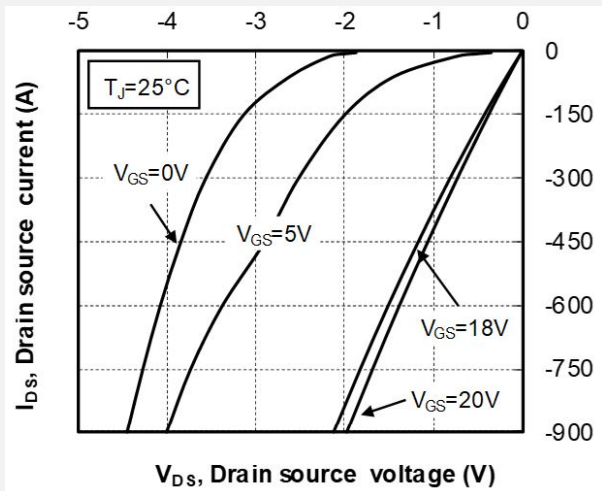


Figure 2-10. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

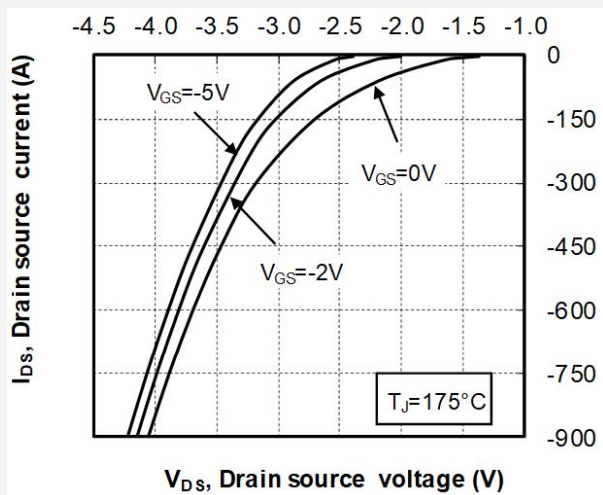
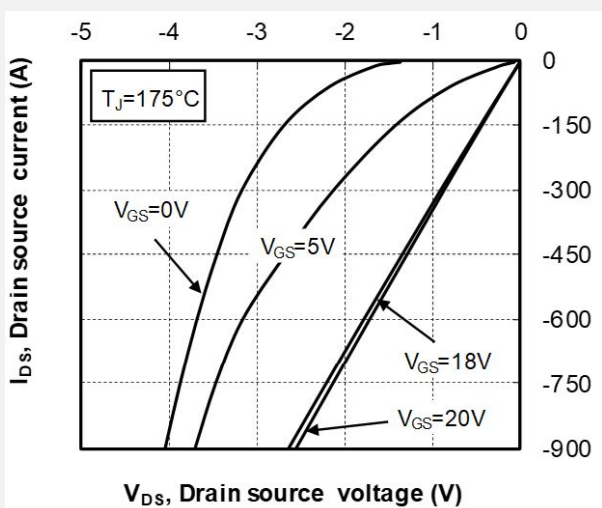


Figure 2-11. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$



MSCSM70AM025CD3AG

Typical SiC MOSFET Performance Curve

Figure 2-12. Switching Energy vs. Current

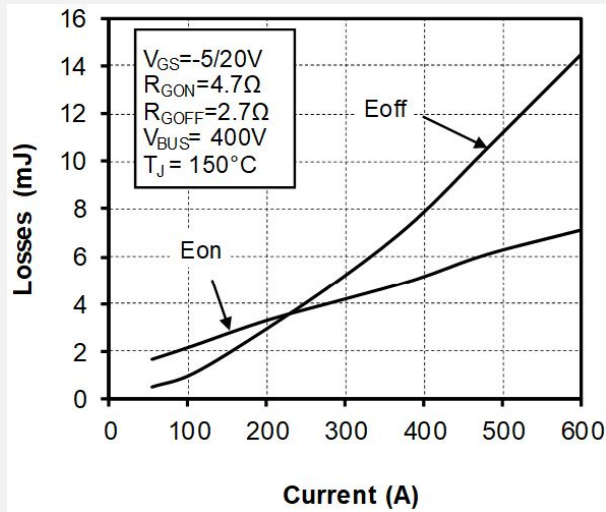


Figure 2-13. Turn On Energy vs. Rg

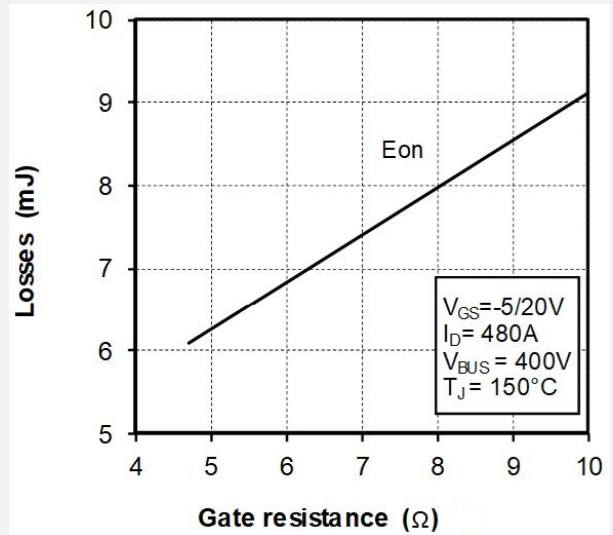


Figure 2-14. Turn Off Energy vs. Rg

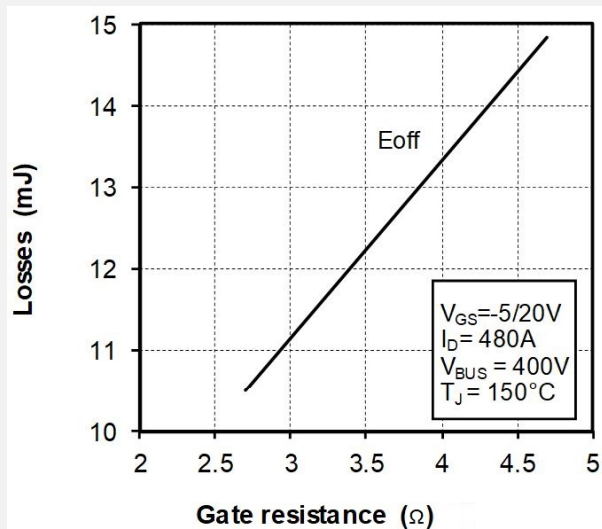
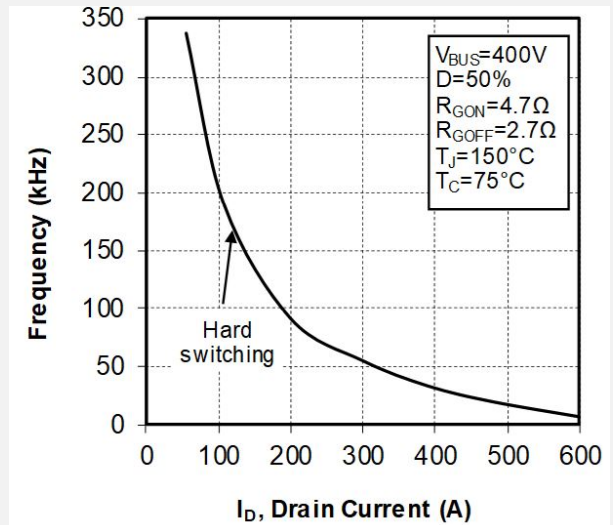


Figure 2-15. Operating Frequency vs. Drain Current



3. Typical SiC Diode Performance Curve

This section shows the typical SiC diode performance curves of MSCSM70AM025CD3AG device.

Figure 3-1. Maximum Thermal Impedance

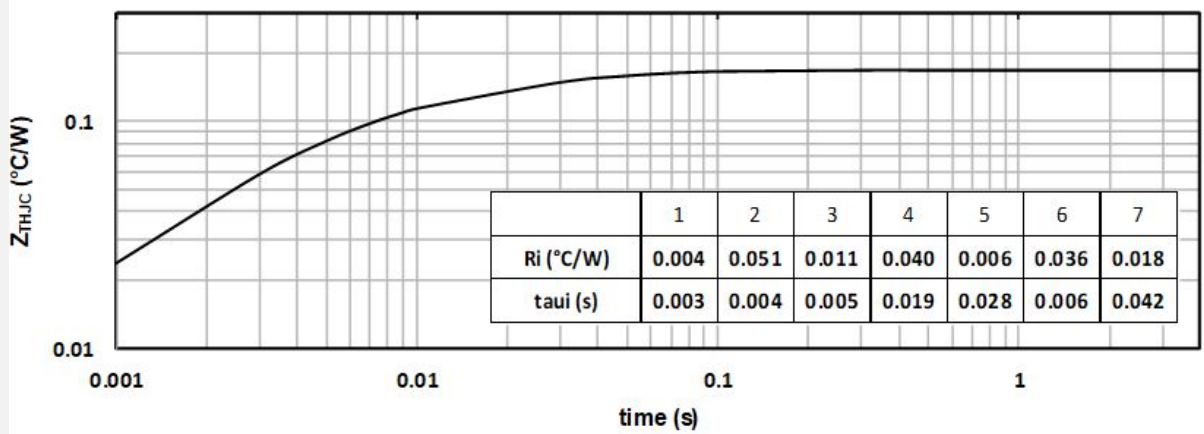


Figure 3-2. Forward Characteristics

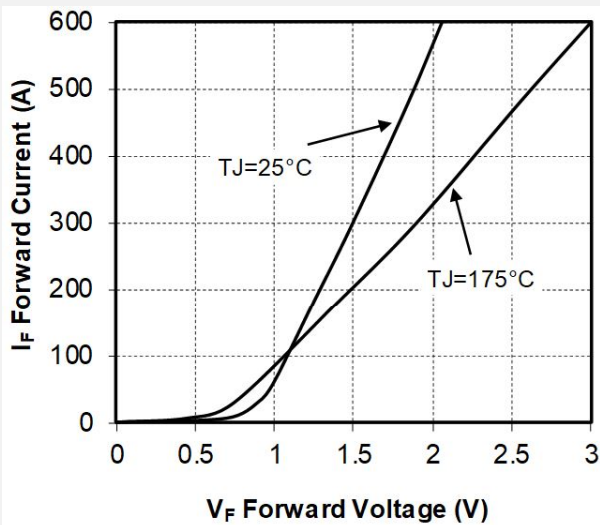
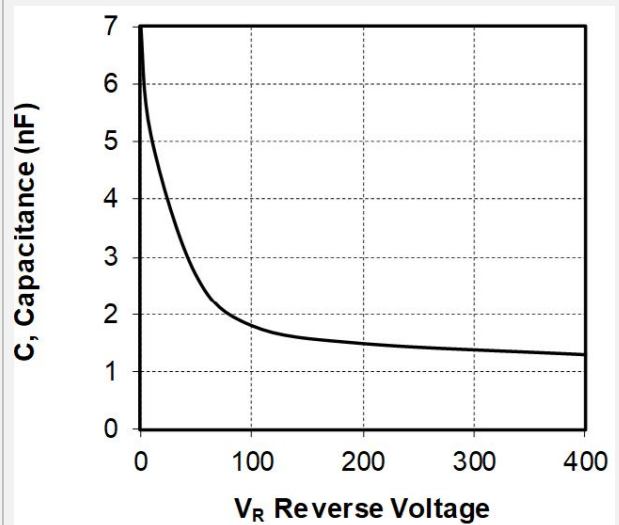


Figure 3-3. Capacitance vs. Reverse Voltage



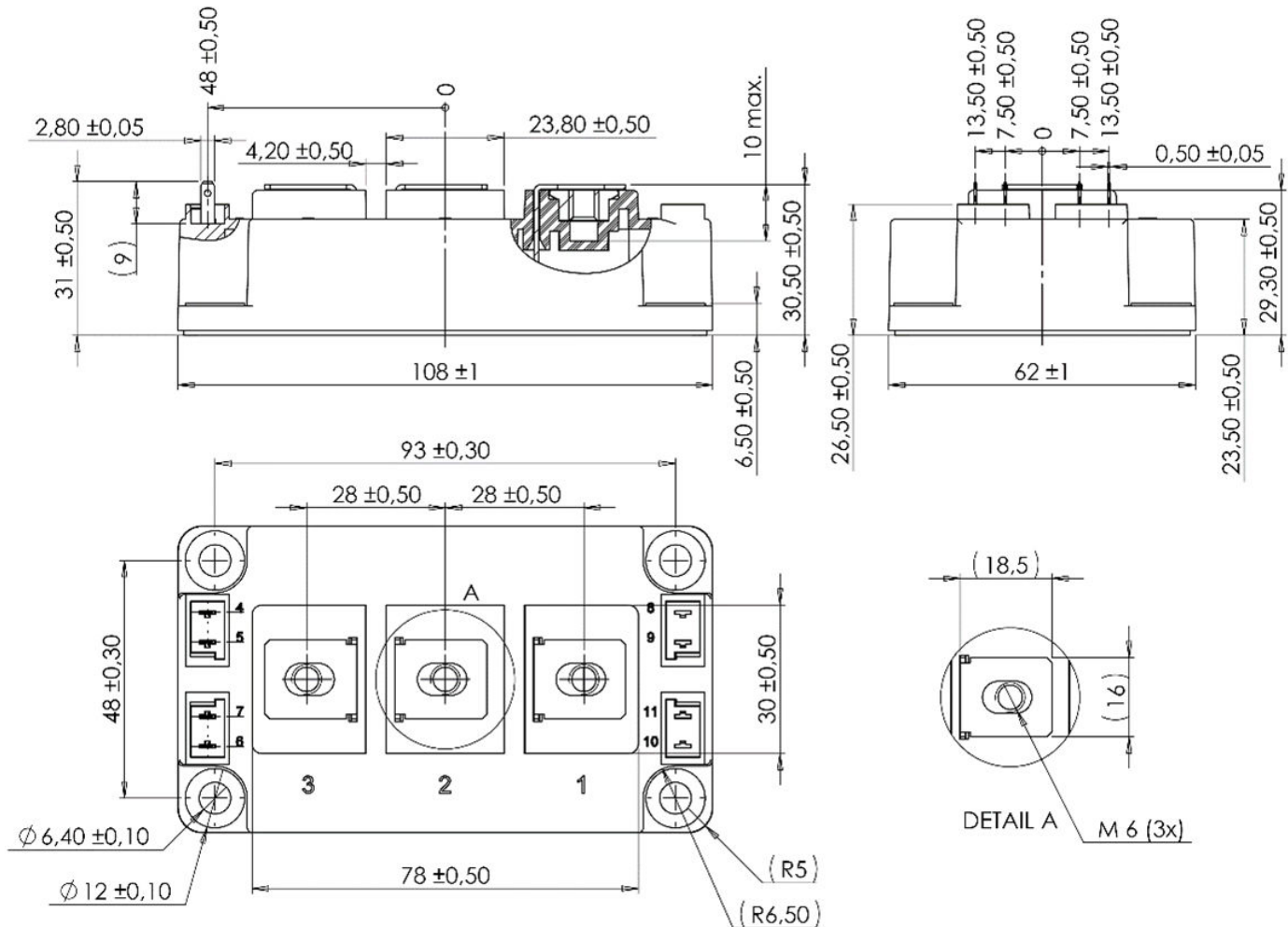
4. Package Specifications

The following section shows the package specification of MSCSM70AM025CD3AG device.

4.1 Package Outline

The following figure shows the package outline drawing of MSCSM70AM025CD3AG device. The dimensions are in millimeters. See *Application Note 1908—Mounting instructions for D3 and D4 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 was changed to DS00003750.

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