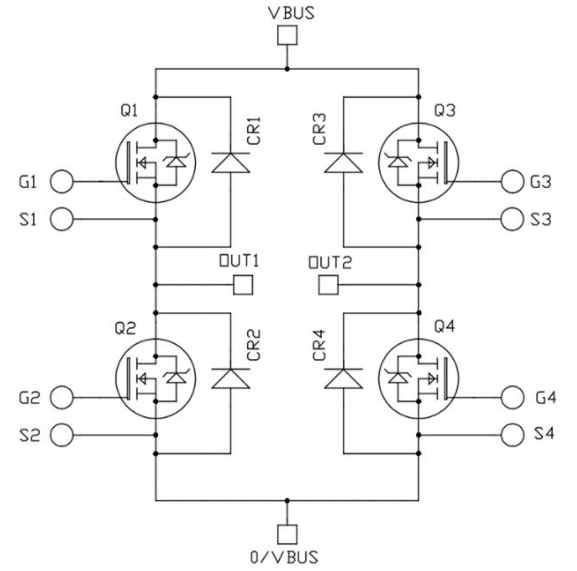
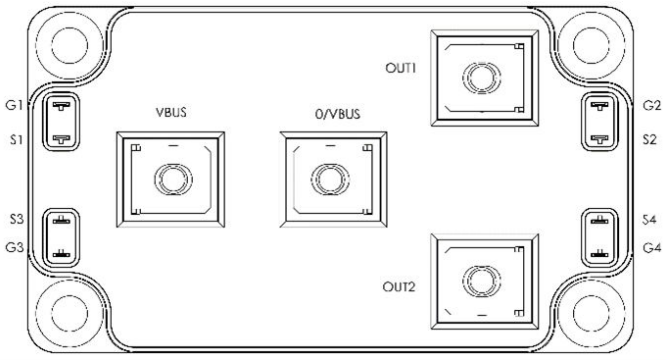
MSCSM70HM038CAG

Full Bridge SiC Power Module

Product Overview

The MSCSM70HM038CAG device is a 700 V/464 A full bridge 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 the key features of MSCSM70HM038CAG 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
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM70HM038CAG device:

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

Applications

The following are the applications of MSCSM70HM038CAG 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 MSCSM70HM038CAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM70HM038CAG device.

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	464	A
		T_C = 80 °C	369	
I_{DM}	Pulsed drain current		900	
V_{GS}	Gate-Source voltage		–10/25	V
$R_{DS(on)}$	Drain-Source ON resistance		4.8	mΩ
P_D	Power dissipation	T_C = 25 °C	1277	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM70HM038CAG 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		—	—	400	µA
$R_{DS(on)}$	Drain-Source on resistance	V_{GS} = 20 V I_D = 160 A	T_J = 25 °C	—	3.8	4.8	mΩ
			T_J = 175 °C	—	4.8	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 16 mA		1.9	2.4	—	V
I_{GSS}	Gate-Source leakage current	V_{GS} = 20 V; V_{DS} = 0 V		—	—	400	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM70HM038CAG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V		—	18	—	nF
C_{oss}	Output capacitance	V_{DS} = 700 V		—	2	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.11	—	
Q_g	Total gate charge	V_{GS} = –5 V/20 V		—	860	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 470 V		—	232	—	
Q_{gd}	Gate-drain charge	I_D = 160 A		—	140	—	
$T_{d(on)}$	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 = 320 A		—	214	—	
T_f	Fall time	T_J = 150 °C R_{GON} = 7 Ω R_{GOFF} = 4 Ω			92	—	
E_{on}	Turn-on energy	V_{GS} = –5 V/20 V	T_J = 150 °C	—	4.1	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400 V I_D = 320 A R_{GON} = 7 Ω R_{GOFF} = 4 Ω	T_J = 150 °C	—	7	—	mJ
R_{Gint}	Internal gate resistance			—	1.4	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.117	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM70HM038CAG 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} = 160 A	—	3.4	—	V
		V_{GS} = –5 V; I_{SD} = 160 A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 160 A	—	40	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5 V	—	2	—	µC
I_{rr}	Reverse recovery current	V_R = 400 V di_F/dt = 4000 A/µs	—	76	—	A

1.2 SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM70HM038CAG device.

Table 1-5. SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

Symbol	Characteristic	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	—	60	800	µA
			T_J = 175 °C	—	1000	—	
I_F	DC forward current	—	T_C = 65 °C	—	200	—	A
V_F	Diode forward voltage	I_F = 200 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		—	532	—	nC
C	Total capacitance	f = 1 MHz, V_R = 200 V		—	992	—	pF
		f = 1 MHz, V_R = 400 V		—	864	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.246	°C/W

1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM70HM038CAG device.

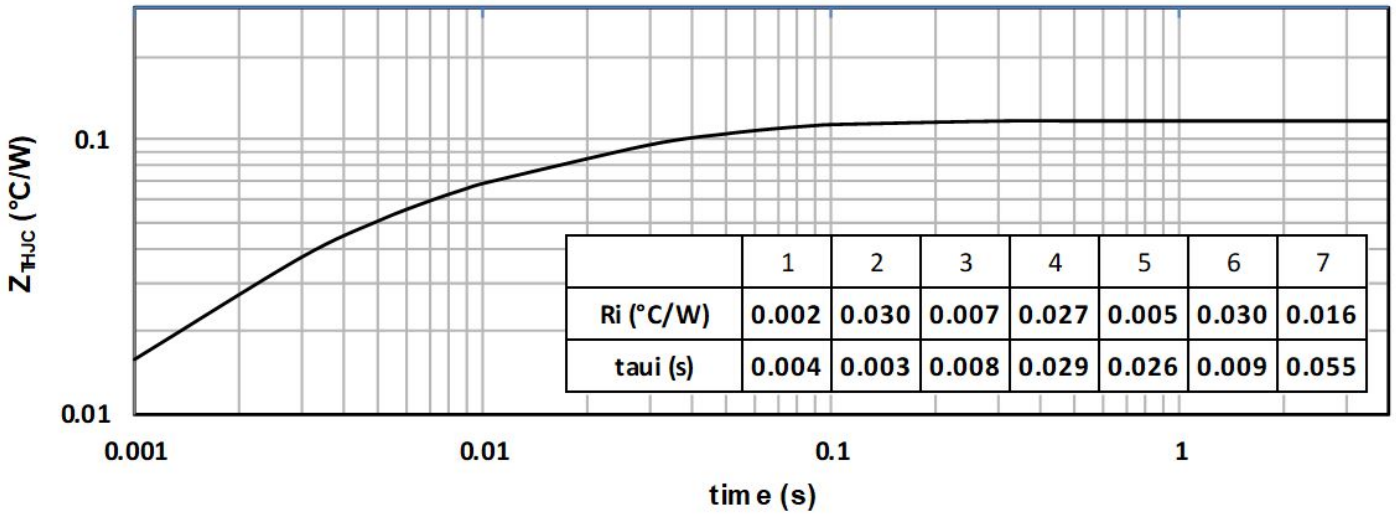
Table 1-6. Thermal and Package Characteristics

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	To heatsink	M6	3	5	N.m
		For terminals	M5	2	3.5	
Wt	Package weight			—	300	g

1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM70HM038CAG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.030	0.007	0.027	0.005	0.030	0.016
taui (s)	0.004	0.003	0.008	0.029	0.026	0.009	0.055

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

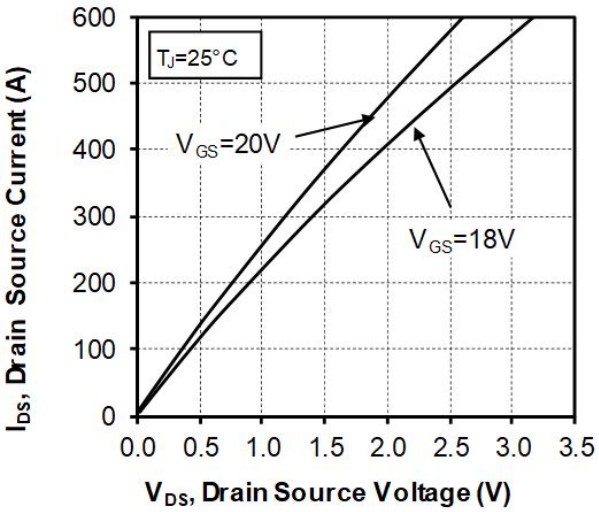


Figure 1-3. Output Characteristics, T_J = 175 °C

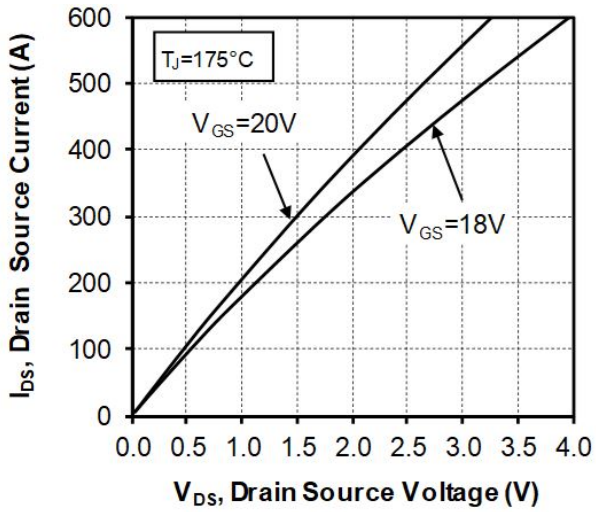


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

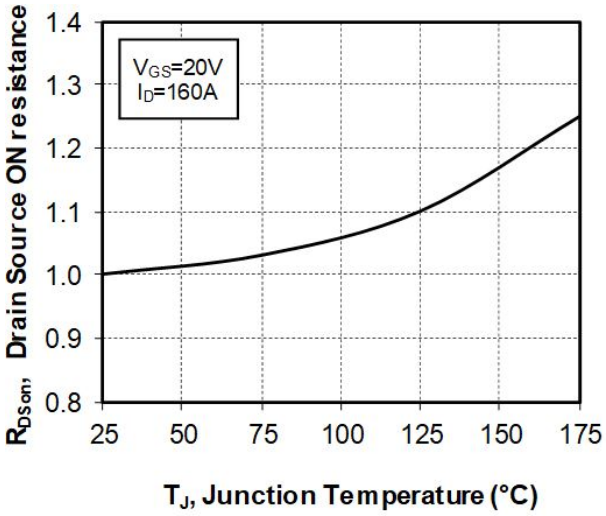


Figure 1-5. Transfer Characteristics

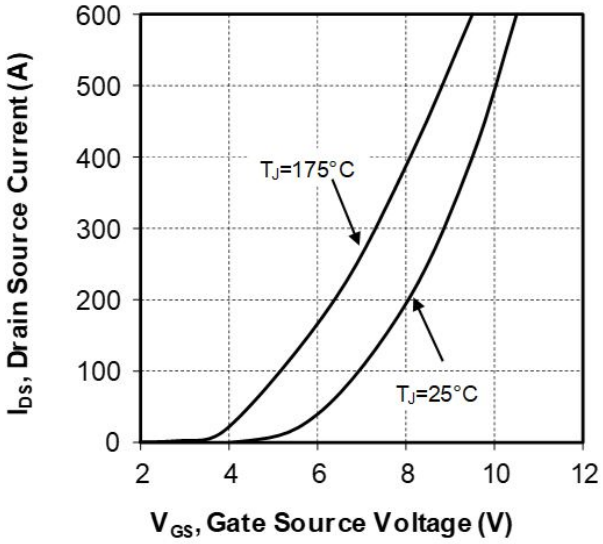


Figure 1-6. Capacitance vs. Drain Source Voltage

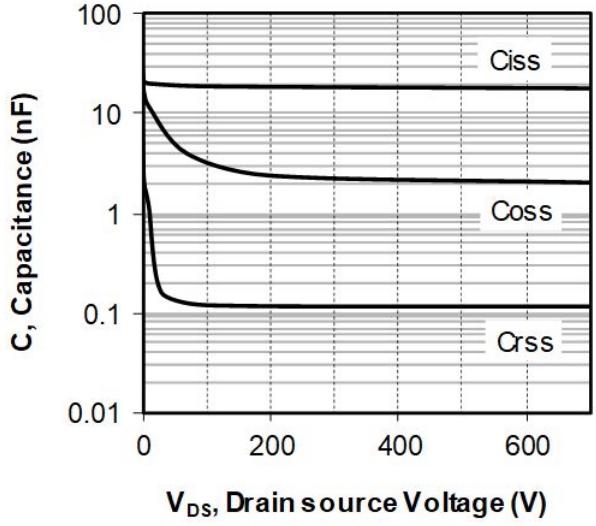


Figure 1-7. Gate Charge vs. Gate Source Voltage

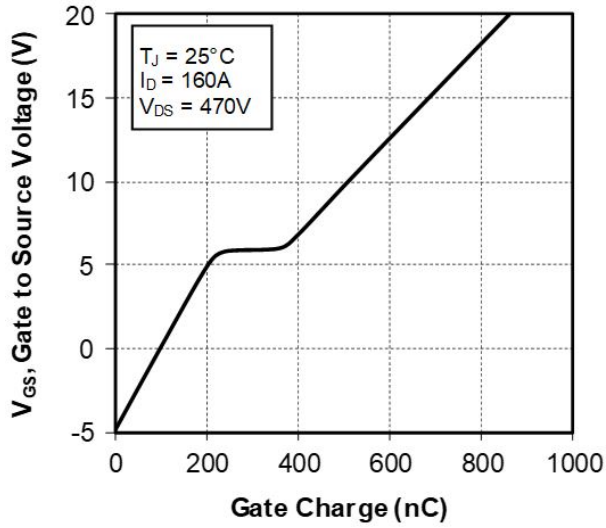


Figure 1-8. Body Diode Characteristics, T_J = 25 °C

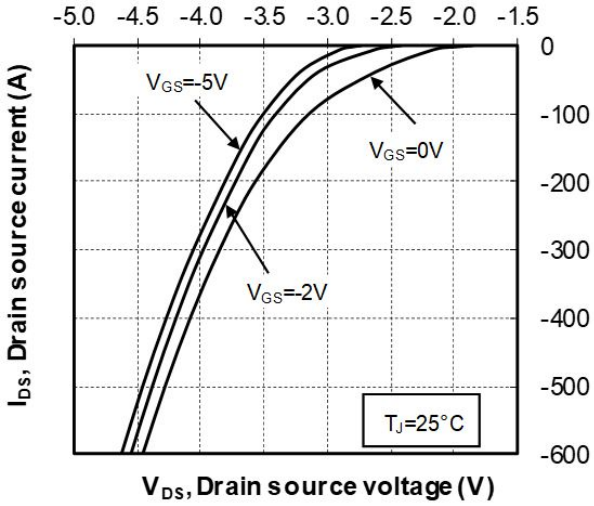


Figure 1-9. 3rd Quadrant Characteristics, T_J = 25 °C

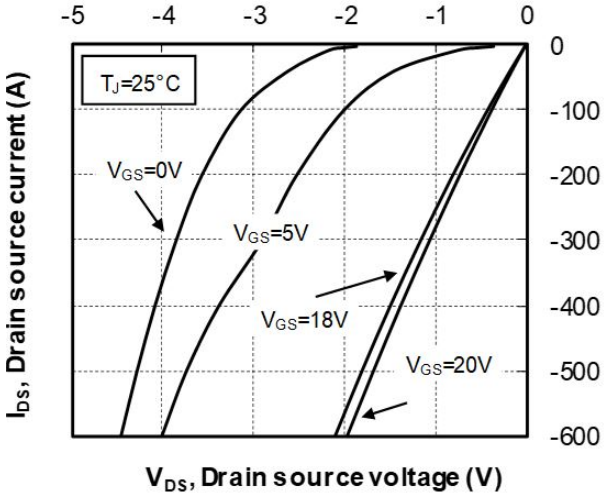


Figure 1-10. Body Diode Characteristics, T_J = 175 °C

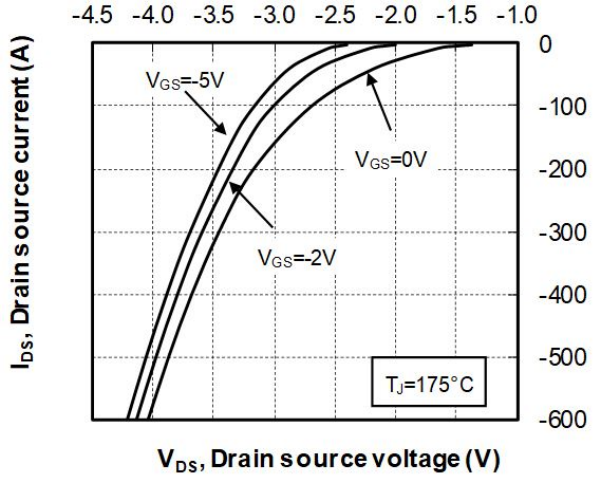


Figure 1-11. 3rd Quadrant Characteristics, T_J = 175 °C

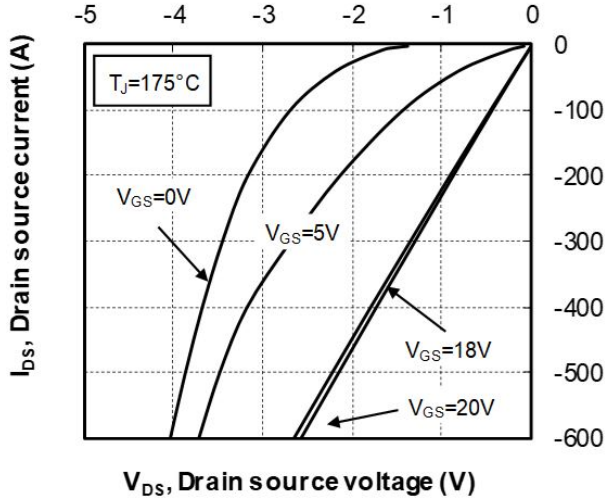


Figure 1-12. Switching Energy vs. Current

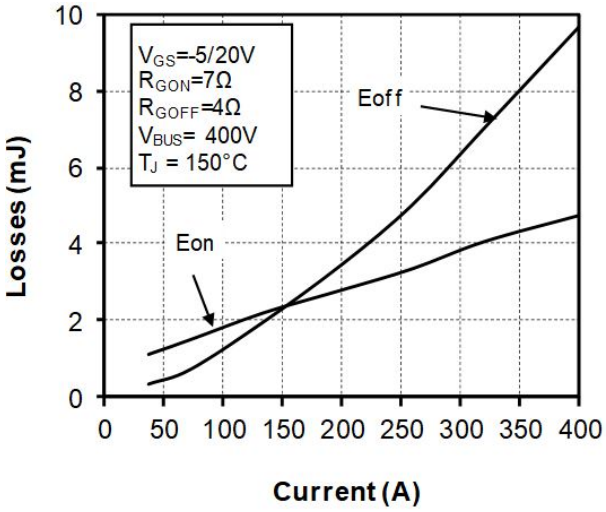


Figure 1-13. Turn On Energy vs. Rg

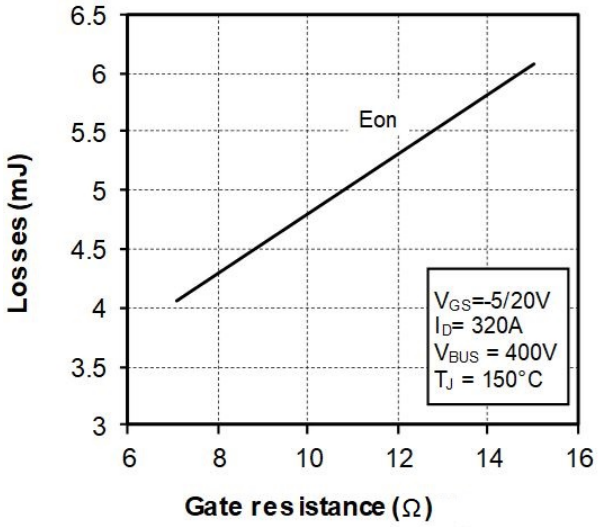


Figure 1-14. Turn Off Energy vs. Rg

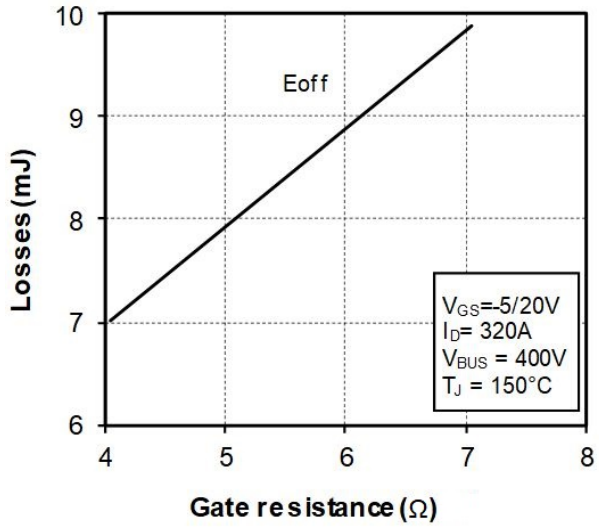
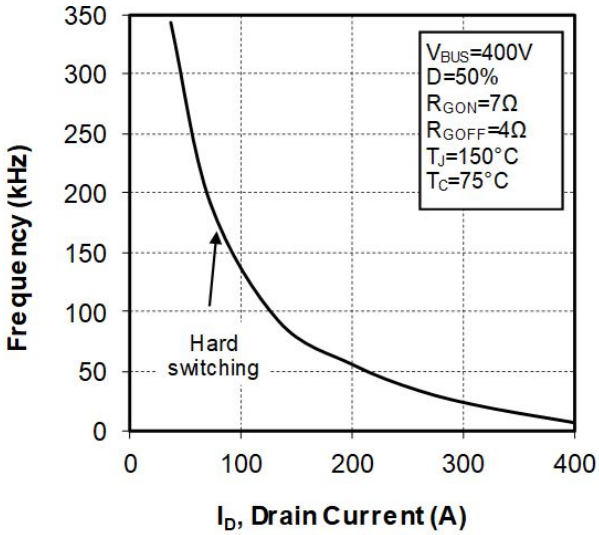


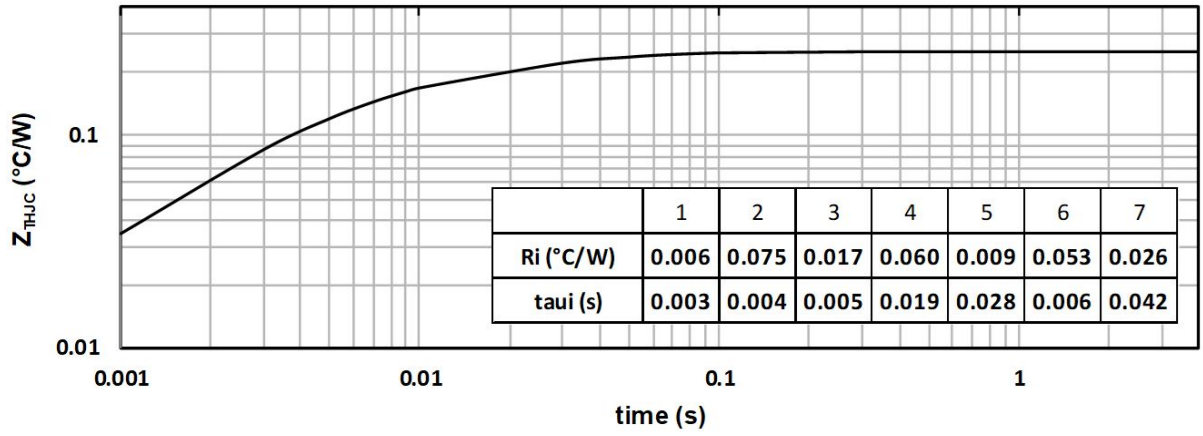
Figure 1-15. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM70HM038CAG device.

Figure 1-16. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.006	0.075	0.017	0.060	0.009	0.053	0.026
taui (s)	0.003	0.004	0.005	0.019	0.028	0.006	0.042

Figure 1-17. Forward Characteristics

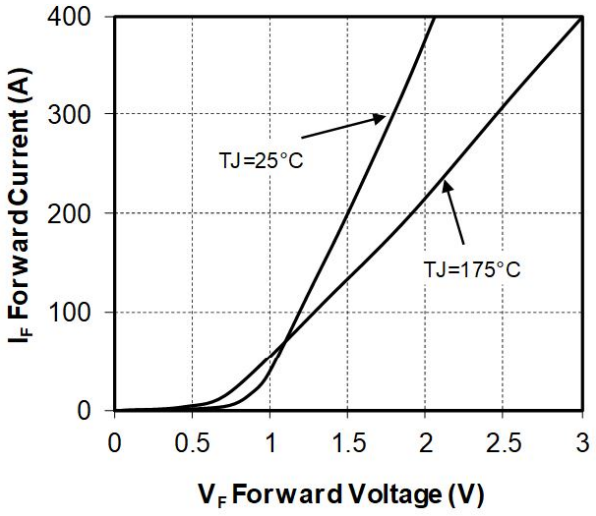
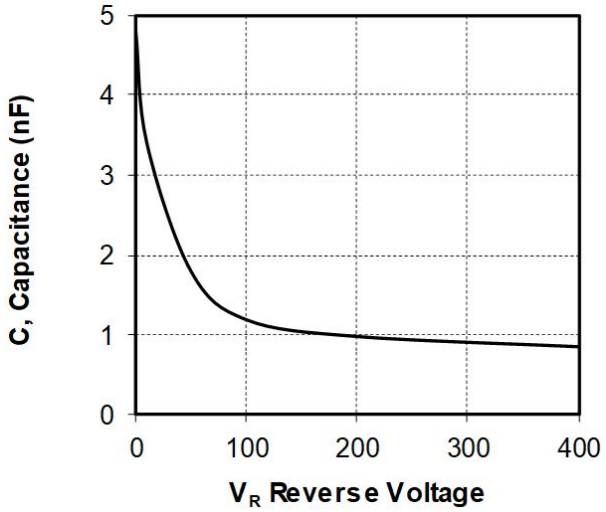


Figure 1-18. Capacitance vs. Reverse Voltage



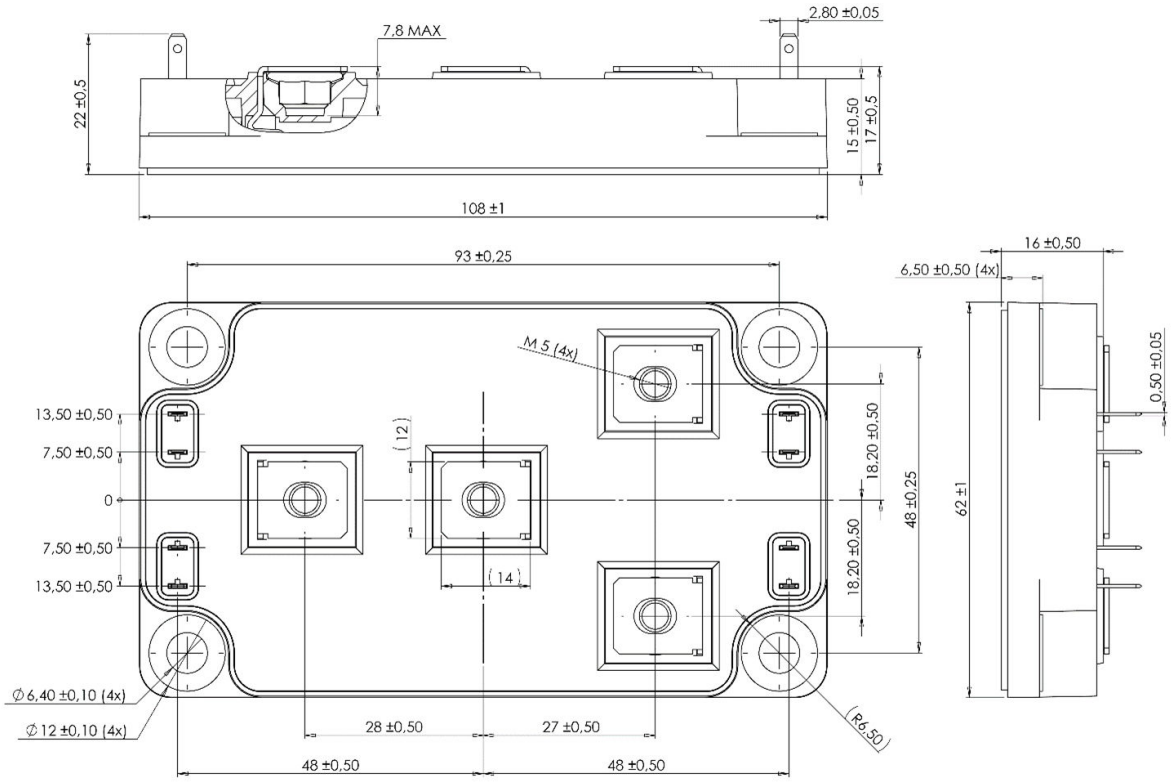
2. Package Specifications

The following section shows the package specification of the MSCSM70HM038CAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70HM038CAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See application note APT0601—Mounting Instructions for SP6 Power Modules.

3. Revision History

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

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