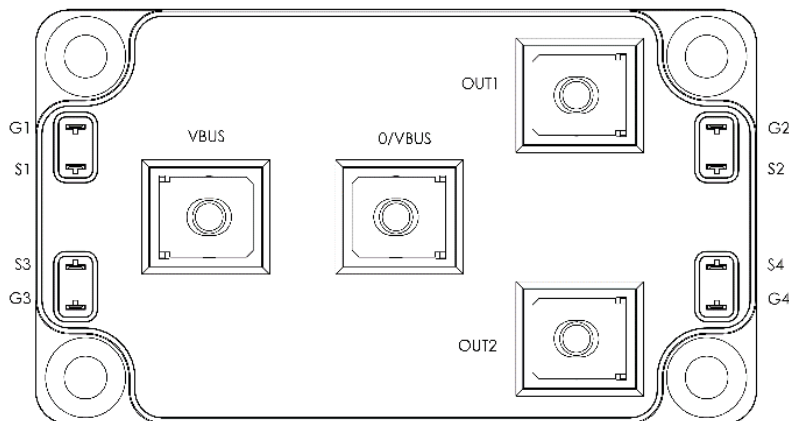
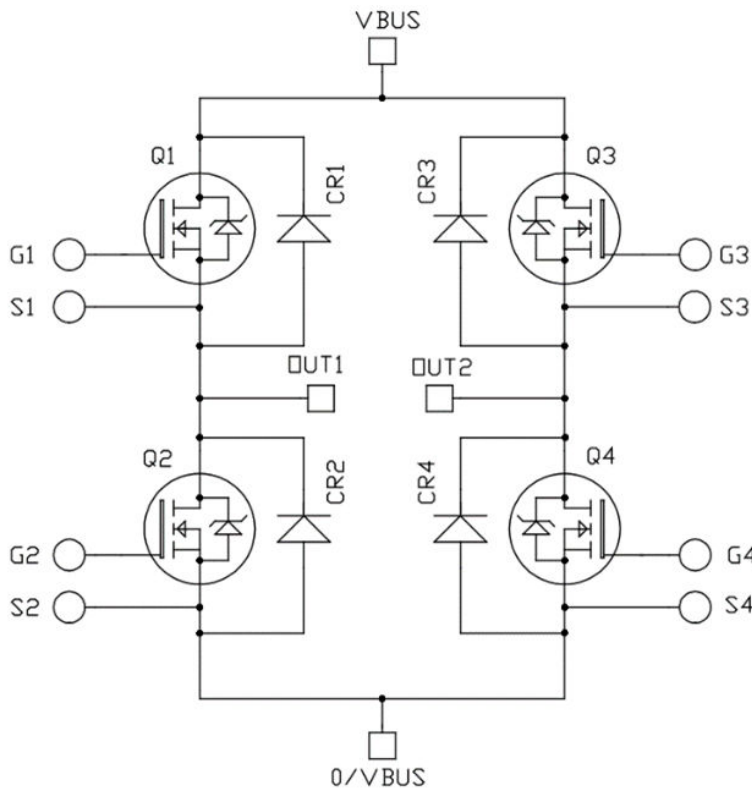


## Full Bridge SiC Power Module

### Product Overview

The MSCSM120HM083CAG device is a 1200 V, 251 A full bridge 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 the key features of MSCSM120HM083CAG 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 MSCSM120HM083CAG 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

## Application

The following are the applications of MSCSM120HM083CAG device:

- 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 MSCSM120HM083CAG device.

### 1.1 SiC MOSFET Characteristics (per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120HM083CAG device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter		Maximum Ratings	Unit
$V_{DS}$	Drain-source voltage		1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	251	A
		$T_C = 80\text{ }^{\circ}\text{C}$	200	
$I_{DM}$	Pulsed drain current		500	
$V_{GS}$	Gate-source voltage		-10/25	V
$R_{DS(on)}$	Drain-source ON resistance		10.4	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	1042	W

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120HM083CAG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 1200\text{ V}$		—	30	300	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 120\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	8.3	10.4	m $\Omega$
			$T_J = 175\text{ }^{\circ}\text{C}$	—	13.3	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ ; $I_D = 3\text{ mA}$		1.8	2.8	—	V
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{ V}$ ; $V_{DS} = 0\text{ V}$		—	—	300	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120HM083CAG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$	—	9	—	nF
$C_{oss}$	Output capacitance	$V_{DS} = 1000\text{ V}$	—	0.81	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.07	—	
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$	—	696	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 800\text{ V}$	—	123	—	
$Q_{gd}$	Gate-drain charge	$I_D = 120\text{ A}$	—	150	—	
$T_{d(on)}$	Turn-on delay time	$T_J = 150\text{ °C}$	—	56	—	ns
$T_r$	Rise time	$V_{GS} = -5\text{ V}/20\text{ V}$	—	55	—	
$T_{d(off)}$	Turn-off delay time	$V_{Bus} = 600\text{ V}$	—	166	—	
$T_f$	Fall time	$I_D = 150\text{ A}$ $R_{GON} = 2.7\text{ }\Omega$ $R_{GOFF} = 1.6\text{ }\Omega$	—	67	—	
$E_{on}$	Turn-on energy	Inductive switching $V_{GS} = -5\text{ V}/20\text{ V}$ $T_J = 150\text{ °C}$	—	3	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 600\text{ V}$ $I_D = 150\text{ A}$ $R_{GON} = 2.7\text{ }\Omega$ $R_{GOFF} = 1.6\text{ }\Omega$ $T_J = 150\text{ °C}$	—	2.7	—	
$R_{Gint}$	Internal gate resistance		—	2	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.144	$^{\circ}\text{C}/\text{W}$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120HM083CAG device.

**Table 1-4. Body Diode Ratings and Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}; I_{SD} = 120\text{ A}$	—	4	—	V
		$V_{GS} = -5\text{ V}; I_{SD} = 120\text{ A}$	—	4.2	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 120\text{ A}$	—	90	—	ns
$Q_{rr}$	Reverse recovery charge	$V_{GS} = -5\text{ V}$	—	1650	—	nC
$I_{rr}$	Reverse recovery current	$V_R = 800\text{ V}$ $di_F/dt = 3000\text{ A}/\mu\text{s}$	—	41	—	A

### 1.2 SiC Schottky Diode Characteristics (per SiC Diode)

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM120HM083CAG 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			—	—	1200	V
$I_{RRM}$	Reverse leakage current	$V_R = 1200\text{ V}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	30	600	$\mu\text{A}$
			$T_J = 175\text{ }^{\circ}\text{C}$	—	450	—	
$I_F$	DC forward current	—	$T_C = 100\text{ }^{\circ}\text{C}$	—	90	—	A
$V_F$	Diode forward voltage	$I_F = 90\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^{\circ}\text{C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$		—	390	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$		—	423	—	pF
		$f = 1\text{ MHz}, V_R = 800\text{ V}$		—	315	—	
$R_{thJC}$	Junction-to-case thermal resistance			—	—	0.34	$^{\circ}\text{C/W}$

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120HM083CAG device.

**Table 1-6. Thermal and Package Characteristics**

Symbol	Characteristic			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 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

This section shows the typical SiC MOSFET performance curves of the MSCSM120HM083CAG device.

Figure 1-1. Maximum Thermal Impedance

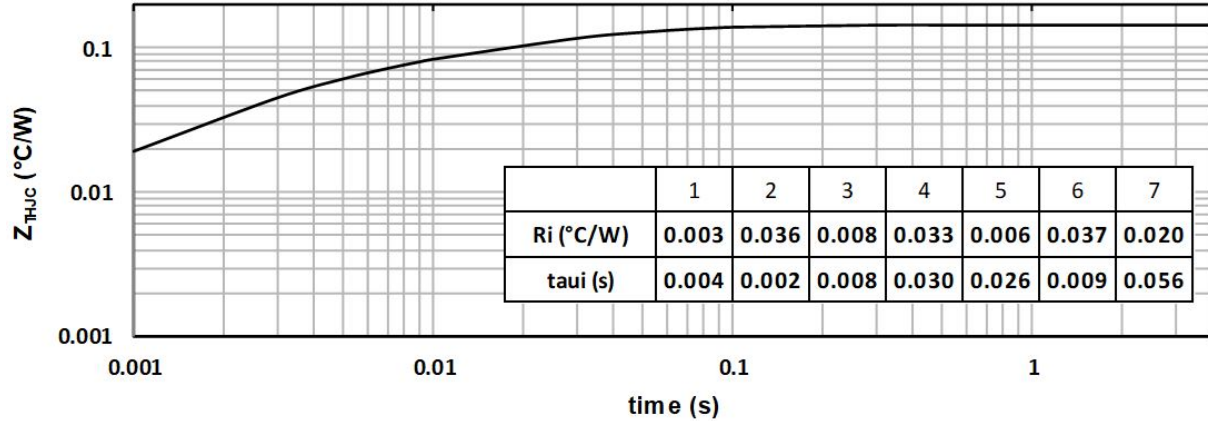


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

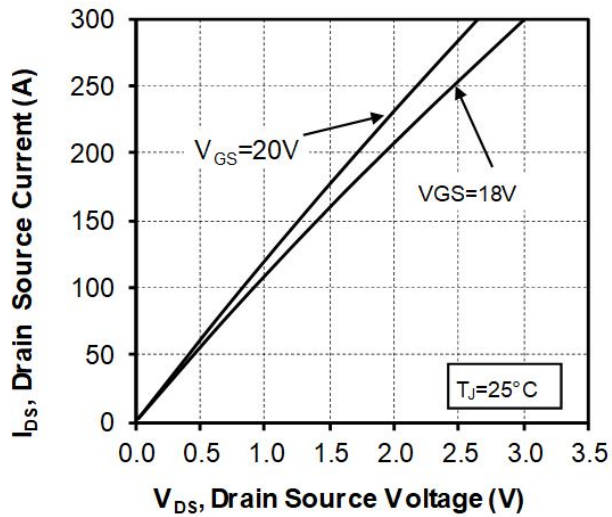


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

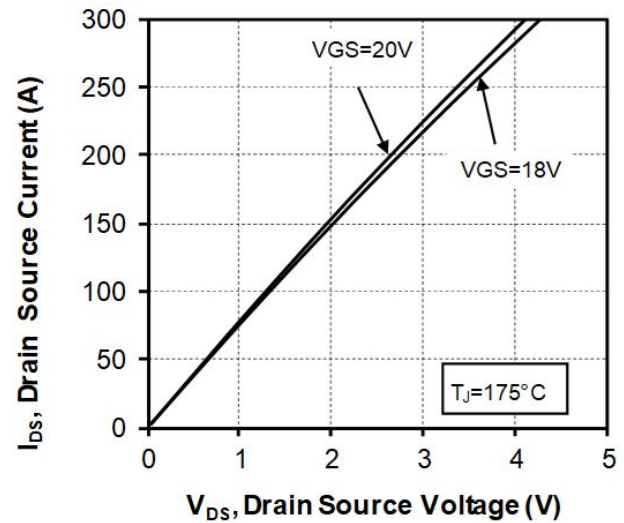


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

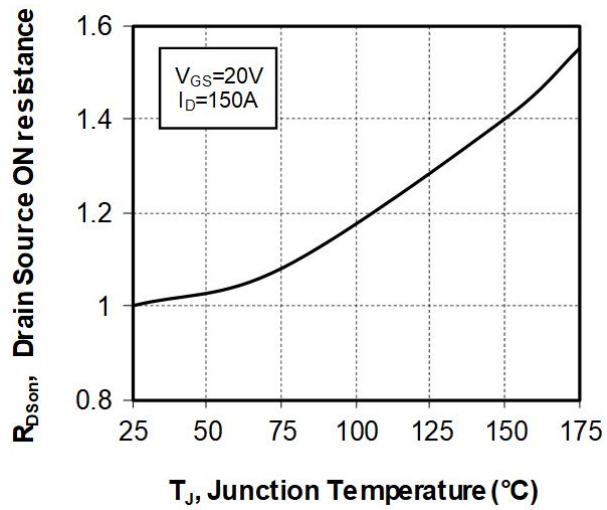


Figure 1-5. Transfer Characteristics

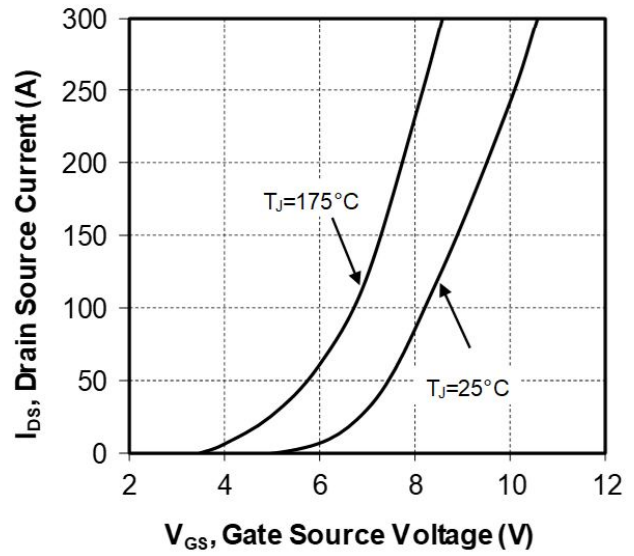


Figure 1-6. Switching Energy vs.  $R_g$

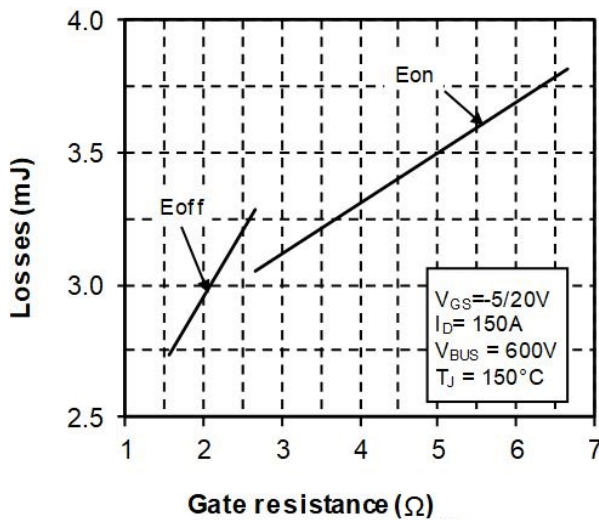


Figure 1-7. Switching Energy vs. Current

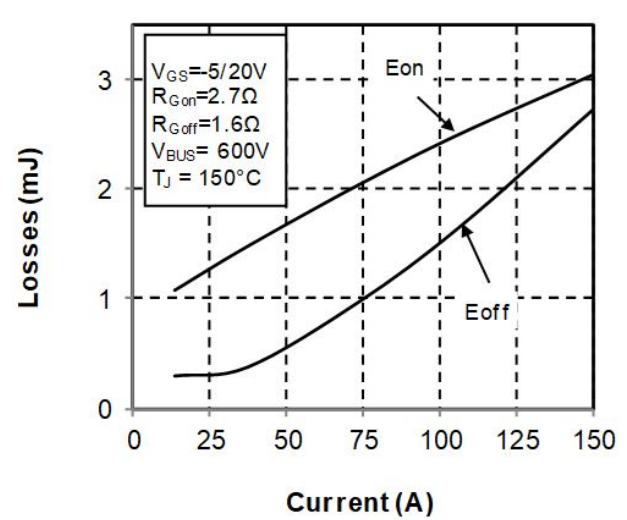


Figure 1-8. Capacitance vs. Drain Source Voltage

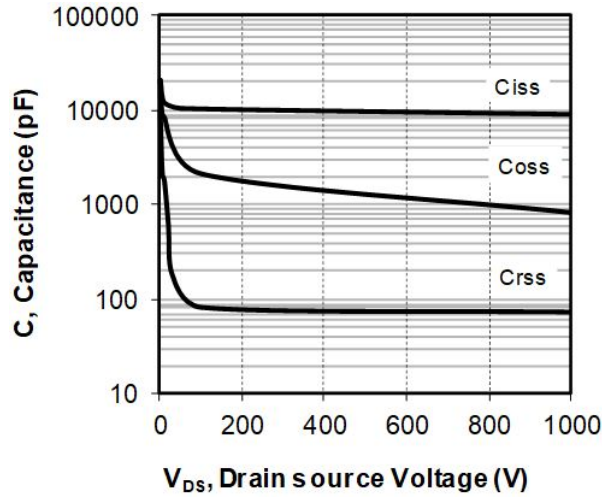


Figure 1-9. Gate Charge vs. Gate Source Voltage

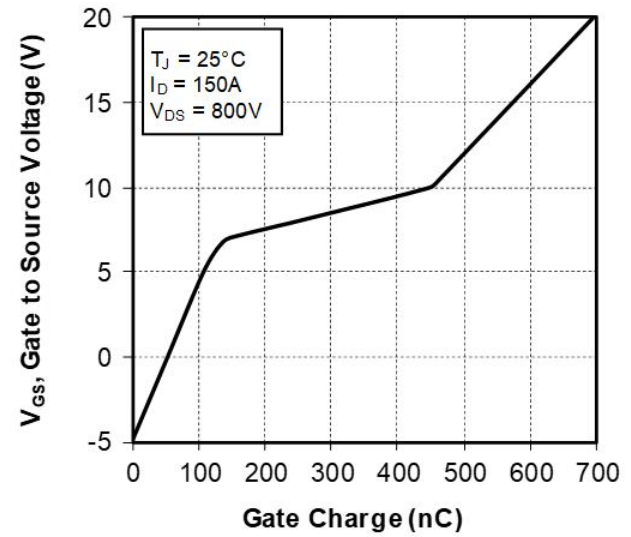


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

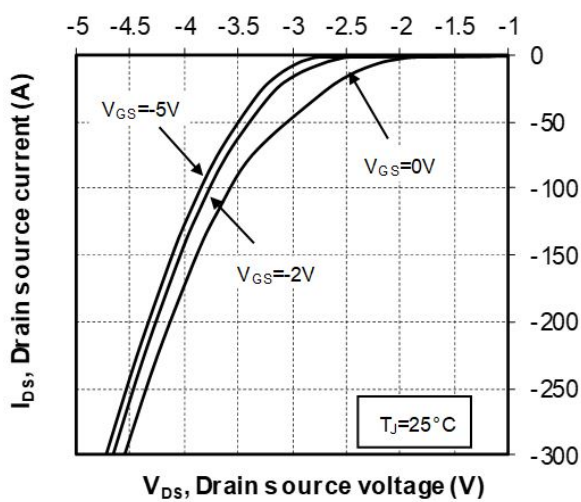


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

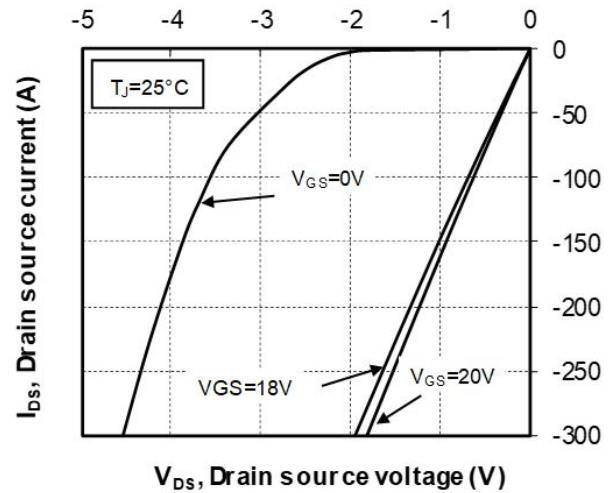




Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

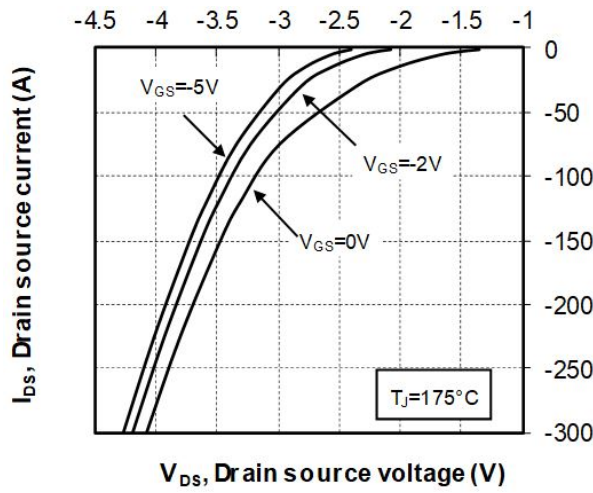


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

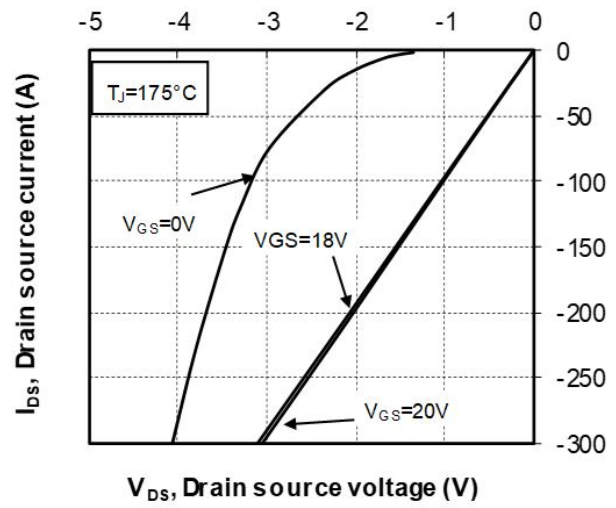
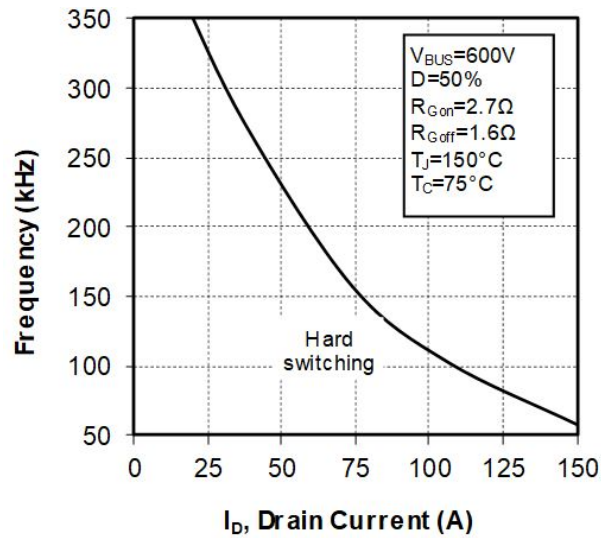


Figure 1-14. Operating Frequency vs Drain Current



### 1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM120HM083CAG device.

Figure 1-15. Maximum Thermal Impedance

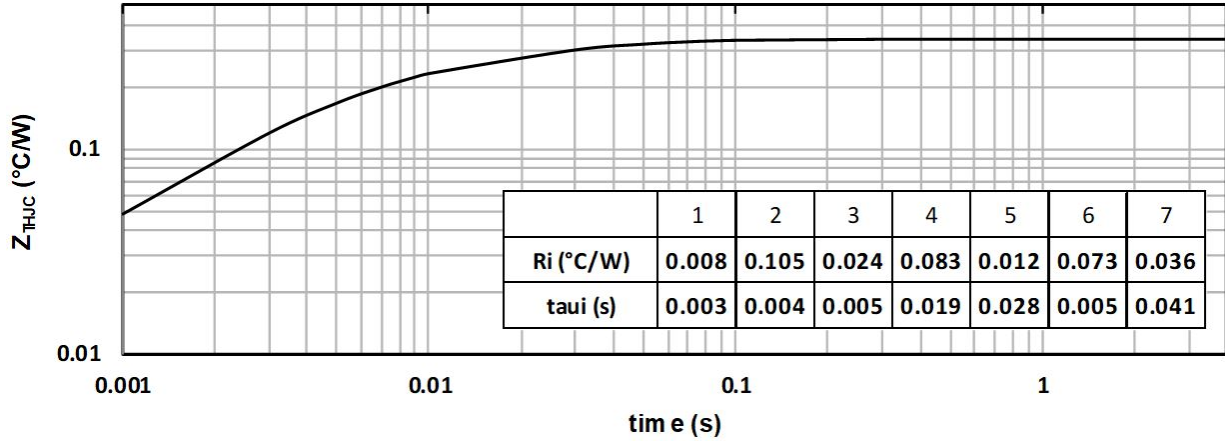


Figure 1-16. Forward Characteristics

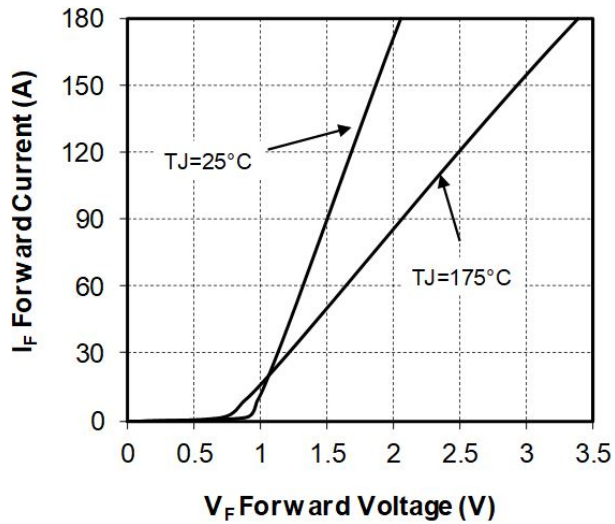
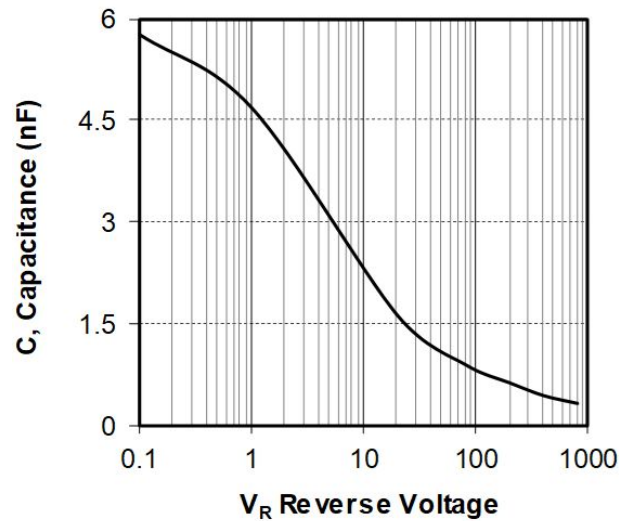


Figure 1-17. Capacitance vs. Reverse Voltage



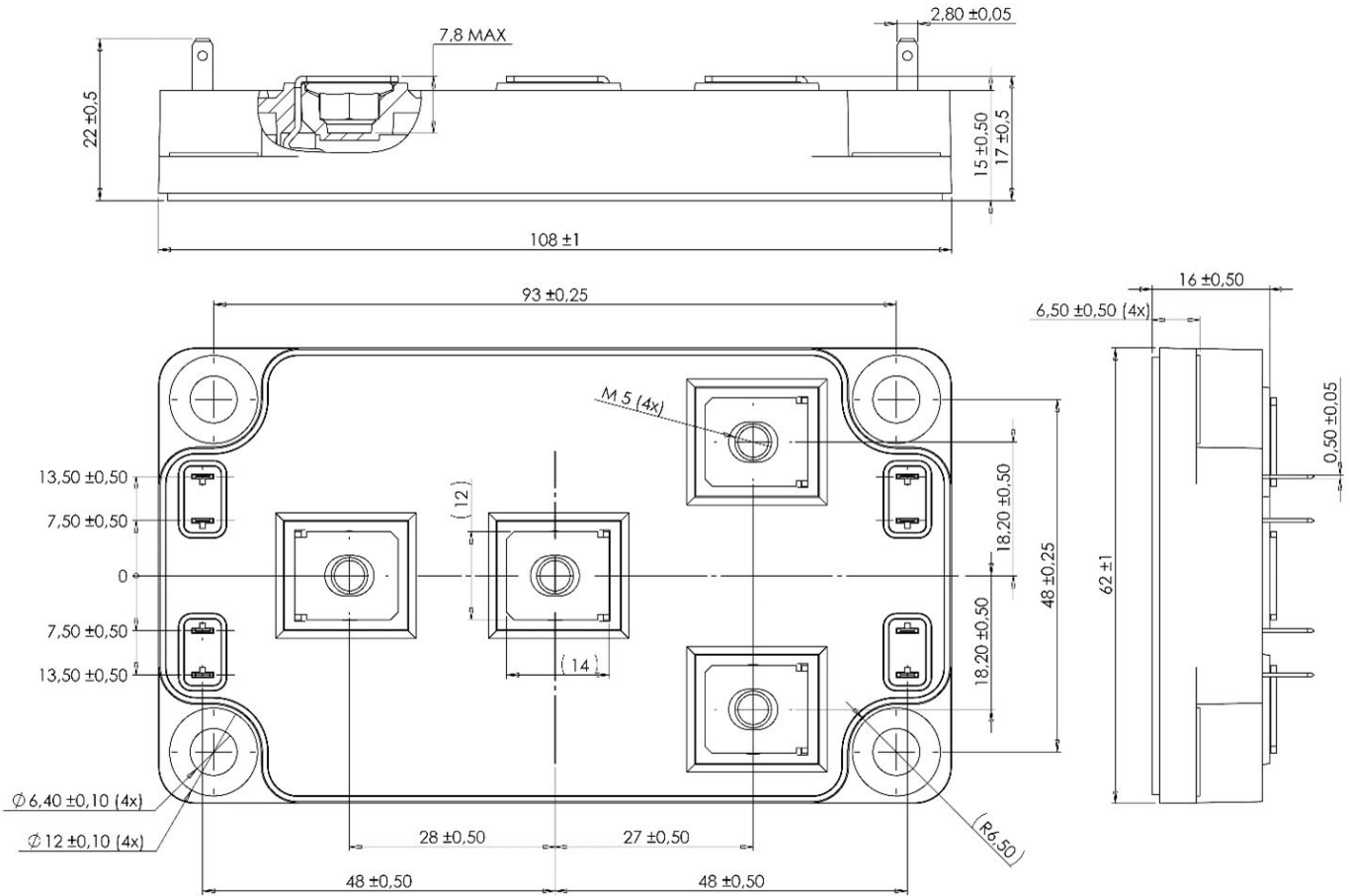
## 2. Package Specifications

The following section shows the package specification of the MSCSM120HM083CAG device.

## 2.1 Package Outline Drawing

The following figure shows the package outline drawing of the MSCSM120HM083CAG 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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