

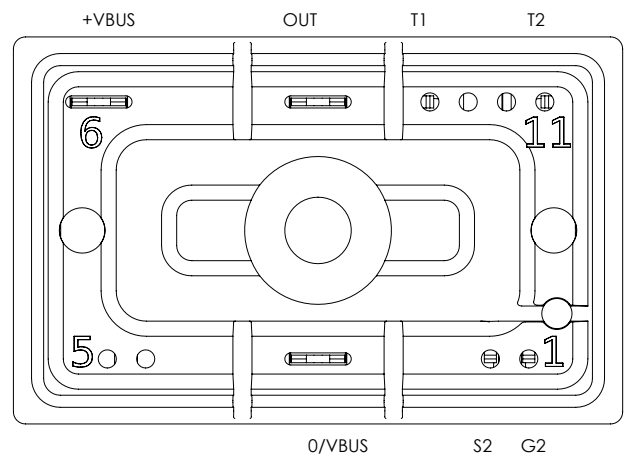
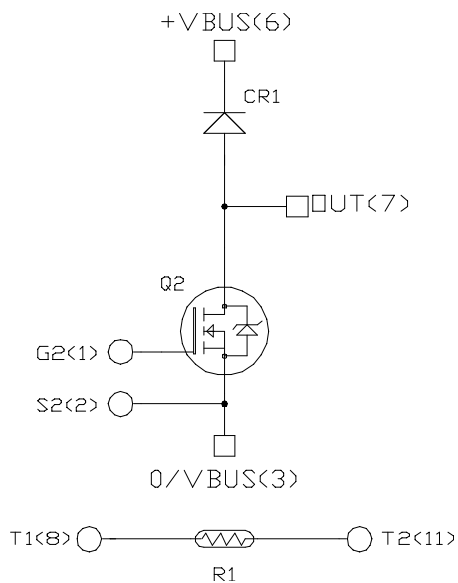
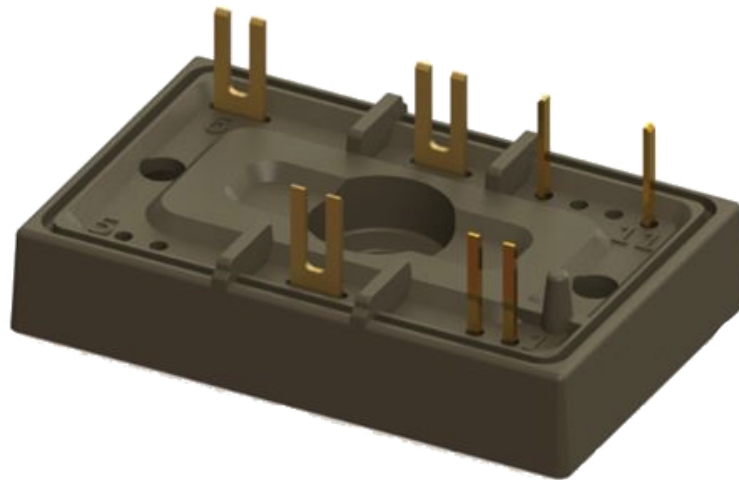


# MSCSM120DAM31CTBL1NG

## Boost Chopper SiC MOSFET Power Module

### Product Overview

The MSCSM120DAM31CTBL1NG device is a 1200 V, 79 A boost chopper silicon carbide (SiC) MOSFET 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

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The following are the key features of MSCSM120DAM31CTBL1NG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High speed switching
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on  $V_F$
- Very low stray inductance
- Ultra-low weight and profile
- Kelvin source for easy drive
- $Si_3N_4$  substrate with thick copper for improved thermal performance
- Internal thermistor for temperature monitoring
- Extended temperature range

## Benefits

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The following are the benefits of MSCSM120DAM31CTBL1NG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-heatsink thermal resistance
- Low profile
- RoHS compliant
- Solderable terminals both for power and signal for easy PCB mounting
- Very integrated power conversion system

## Application

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The following are the applications of MSCSM120DAM31CTBL1NG device:

- High reliability power systems
- High Efficiency AC/DC and DC/AC converters
- Motor control

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120DAM31CTBL1NG device.

### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of MSCSM120DAM31CTBL1NG device.

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

Symbol	Parameter		Maximum Ratings	Unit
$V_{DS}$	Drain-Source voltage		1200	V
$I_D$	Continuous drain current	$T_H = 25\text{ }^{\circ}\text{C}$	79	A
		$T_H = 80\text{ }^{\circ}\text{C}$	63	
$I_{DM}$	Pulsed drain current		160	
$V_{GS}$	Gate-Source voltage		-10/25	V
$R_{DS(on)}$	Drain-Source ON resistance		31	m $\Omega$
$P_D$	Power dissipation	$T_H = 25\text{ }^{\circ}\text{C}$	310	W

The following table lists the electrical characteristics of MSCSM120DAM31CTBL1NG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ $V_{DS} = 1200\text{ V}$		—	10	100	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	25	31	m $\Omega$
			$T_J = 175\text{ }^{\circ}\text{C}$	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 1\text{ mA}$		1.8	2.8	—	V
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{ V}$ $V_{DS} = 0\text{ V}$		—	—	150	nA

The following table lists the dynamic characteristics of MSCSM120DAM31CTBL1NG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C <sub>iss</sub>	Input capacitance	V <sub>GS</sub> = 0 V	—	3020	—	pF
C <sub>oss</sub>	Output capacitance	V <sub>DS</sub> = 1000 V	—	270	—	
C <sub>rss</sub>	Reverse transfer capacitance	f = 1 MHz	—	25	—	
Q <sub>g</sub>	Total gate charge	V <sub>GS</sub> = -5 V/20 V	—	232	—	nC
Q <sub>gs</sub>	Gate-Source charge	V <sub>Bus</sub> = 800 V	—	41	—	
Q <sub>gd</sub>	Gate-Drain charge	I <sub>D</sub> = 40 A	—	50	—	
T <sub>d(on)</sub>	Turn-on delay time	V <sub>GS</sub> = -5 V/20 V	—	30	—	ns
T <sub>r</sub>	Rise time	V <sub>Bus</sub> = 600 V	—	30	—	
T <sub>d(off)</sub>	Turn-off delay time	I <sub>D</sub> = 50 A	—	50	—	
T <sub>f</sub>	Fall time	R <sub>Gon</sub> = 8 Ω R <sub>Goff</sub> = 4.7 Ω	—	25	—	
E <sub>on</sub>	Turn-on energy	V <sub>GS</sub> = -5 V/20 V	T <sub>J</sub> = 150 °C	0.99	—	mJ
E <sub>off</sub>	Turn-off energy	V <sub>Bus</sub> = 600 V I <sub>D</sub> = 50 A R <sub>Gon</sub> = 8 Ω R <sub>Goff</sub> = 4.7 Ω		0.66	—	
R <sub>Gint</sub>	Internal gate resistance		—	0.88	—	Ω
R <sub>thJH</sub>	Junction-to-heatsink thermal resistance	λ = 3.4 W/mK	—	0.483	—	°C/W

The following table lists the body diode ratings and characteristics of MSCSM120DAM31CTBL1NG device.

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

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V <sub>SD</sub>	Diode forward voltage	V <sub>GS</sub> = 0 V I <sub>SD</sub> = 40 A	—	4	—	V
		V <sub>GS</sub> = -5 V I <sub>SD</sub> = 40 A	—	4.2	—	
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 40 A	—	90	—	ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>GS</sub> = -5 V	—	550	—	nC
I <sub>rr</sub>	Reverse recovery current	V <sub>R</sub> = 800 V di <sub>F</sub> /dt = 1000 A/μs	—	13.5	—	A

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

The following table lists the SiC diode ratings and characteristics of MSCSM120DAM31CTBL1NG device.

**Table 1-5. SiC Diode Ratings and Characteristics**

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
$V_{RRM}$	Peak repetitive reverse voltage			—	—	1200	V
$I_{RM}$	Reverse leakage current	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$	—	10	200	$\mu\text{A}$
			$T_J = 175\text{ °C}$	—	250	—	
$I_F$	DC forward current	$T_H = 100\text{ °C}$		—	50	—	A
$V_F$	Diode forward voltage	$I_F = 50\text{ A}$	$T_J = 25\text{ °C}$	—	1.5	1.8	V
			$T_J = 175\text{ °C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$		—	224	—	nC
C	Total capacitance	$f = 1\text{ MHz}$		—	246	—	pF
		$V_R = 400\text{ V}$		—	—	—	
		$f = 1\text{ MHz}$		—	182	—	
	$V_R = 800\text{ V}$		—	—	—	—	—
$R_{thJH}$	Junction-to-heatsink thermal resistance	$\lambda_{paste} = 3.4\text{ W/mK}$		—	0.635	—	$^{\circ}\text{C/W}$

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120DAM31CTBL1NG device.

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

Symbol	Characteristic			Min	Typ	Max	Unit
$V_{ISOL}$	RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50 Hz/60 Hz			2500	—	—	V
$T_J$	Operating junction temperature range			–55	—	175	$^{\circ}\text{C}$
$T_{JOP}$	Recommended junction temperature under switching conditions			–55	—	$T_{Jmax}-25$	
$T_{STG}$	Storage case temperature			–55	—	125	
$T_C$	Operating case temperature			–55	—	125	
Torque	Mounting torque	To heatsink	M4	1.5	—	2	N.m
Wt	Package weight			—	13.5	—	g

The following table lists the temperature sensor NTC of the MSCSM120DAM31CTBL1NG device.

**Table 1-7. Temperature Sensor NTC**

Symbol	Characteristic	Min	Typ	Max	Unit
R <sub>25</sub>	Resistance at 25 °C	—	50	—	kΩ
ΔR <sub>25</sub> /R <sub>25</sub>	—	—	5	—	%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15 K	—	3952	—	K
ΔB/B	— T <sub>C</sub> = 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<sub>T</sub>: Thermistor value at T

**Note:** See [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#) for more information.

## 1.4 Typical SiC MOSFET Performance Curve (Per SiC MOSFET)

This section shows the typical SiC MOSFET performance curves of the MSCSM120DAM31CTBL1NG device.

**Figure 1-1. Junction-to-Heatsink Thermal Impedance**

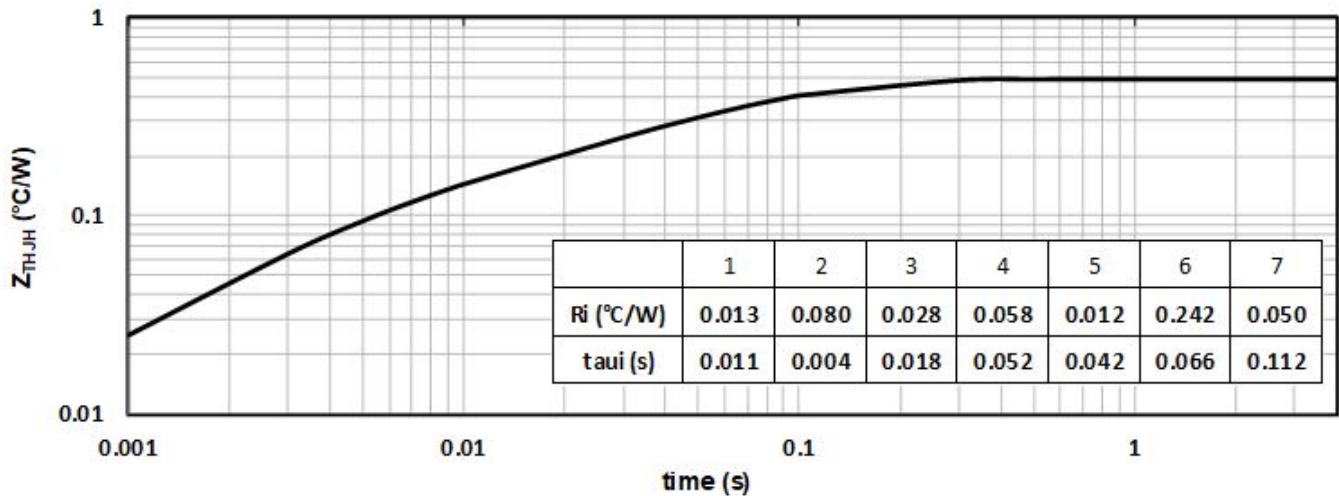


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

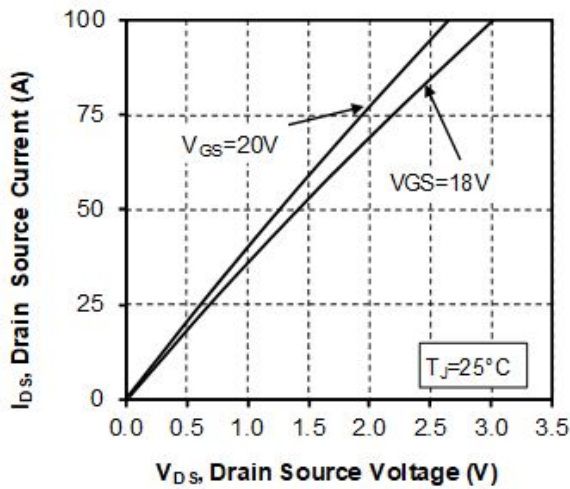


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

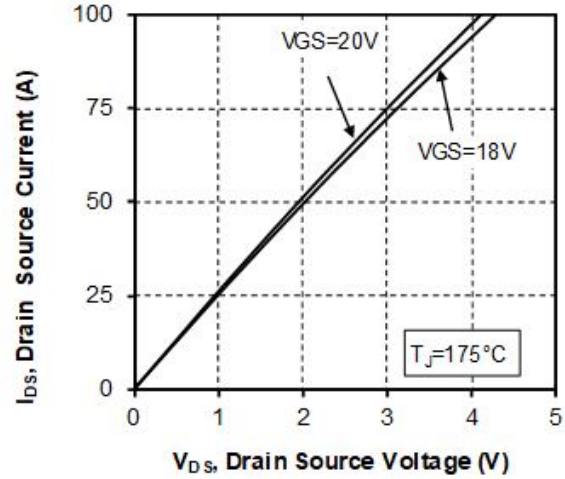


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

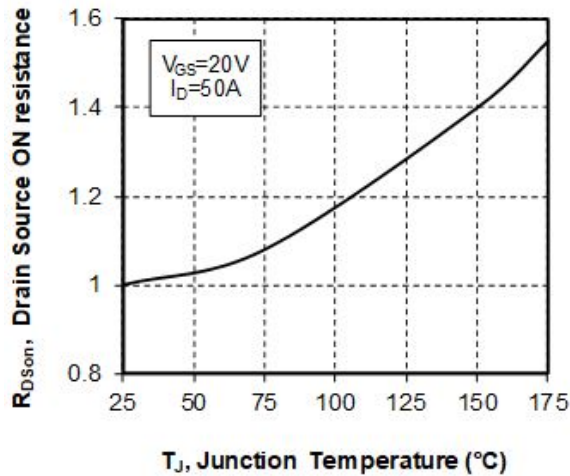


Figure 1-5. Transfer Characteristics

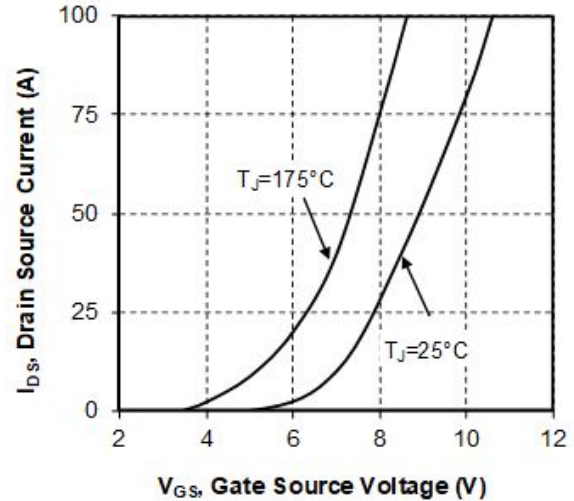


Figure 1-6. Switching Energy vs.  $R_g$

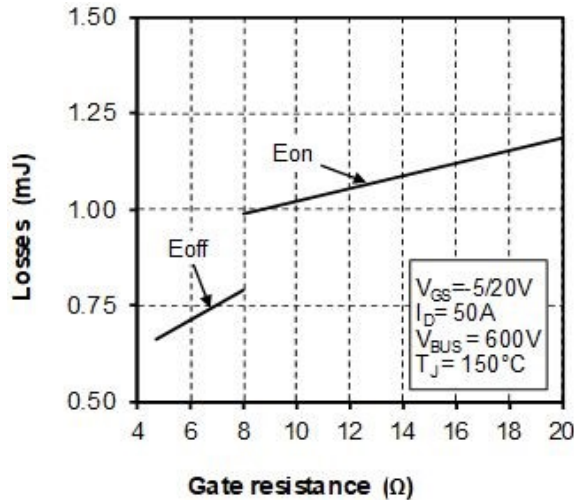


Figure 1-7. Switching Energy vs. Current

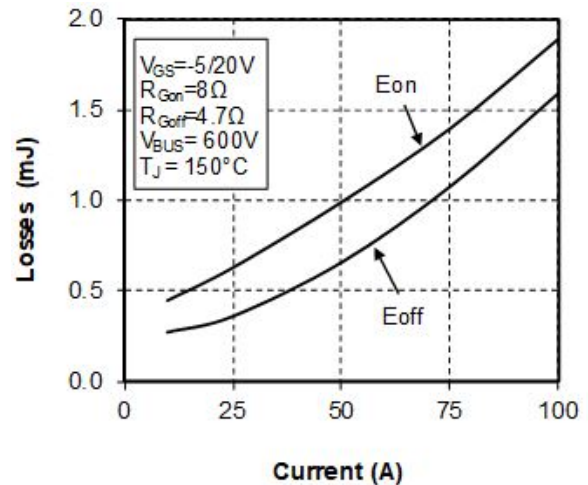




Figure 1-8. Capacitance vs. Drain Source Voltage

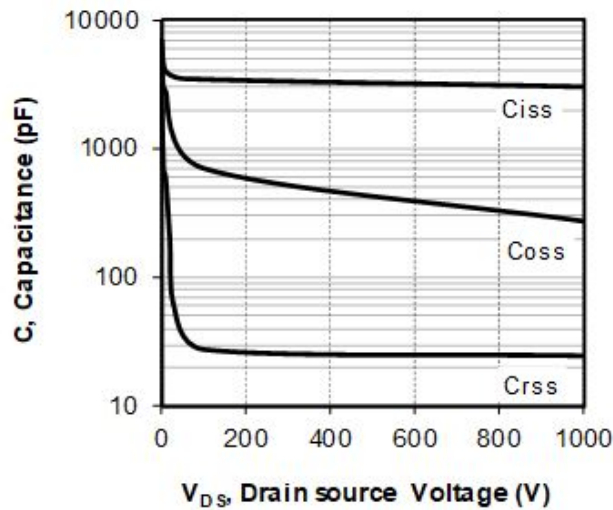


Figure 1-9. Gate Charge vs. Gate Source Voltage

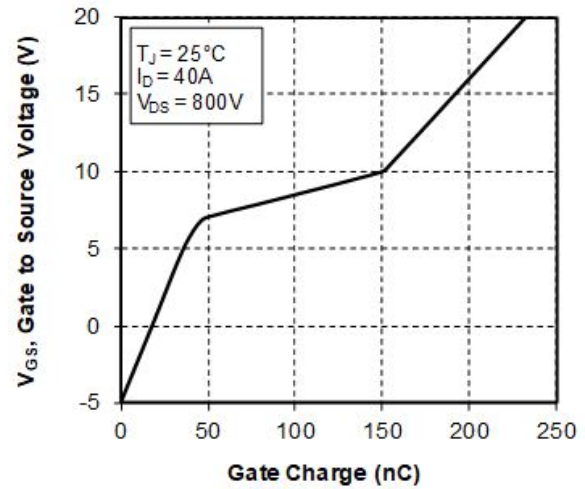


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

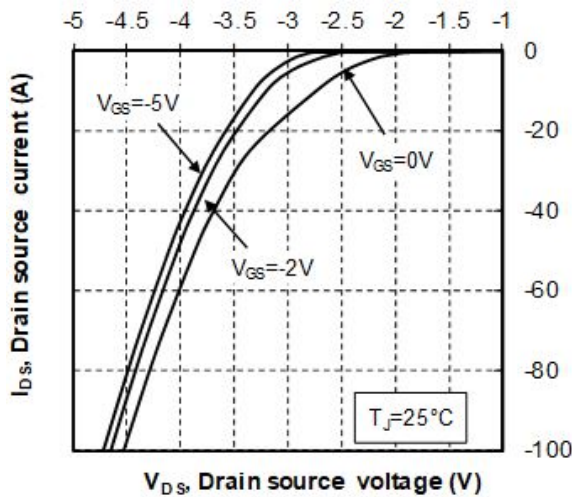


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

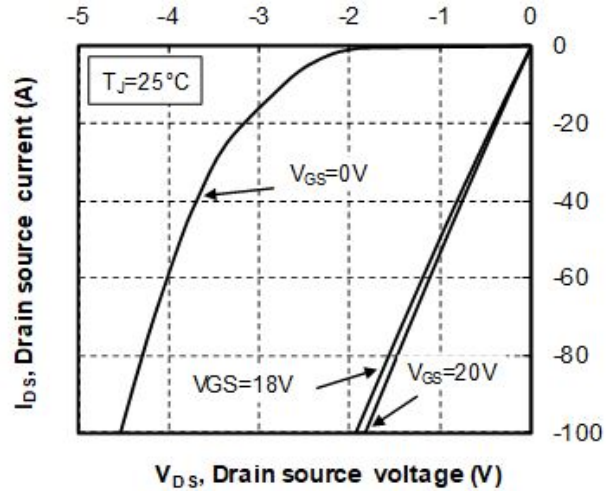


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

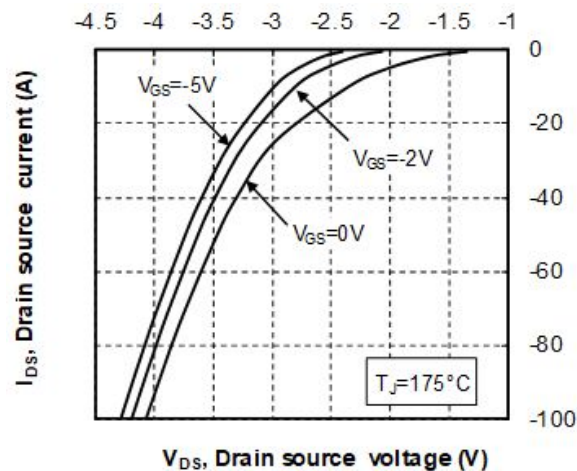


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

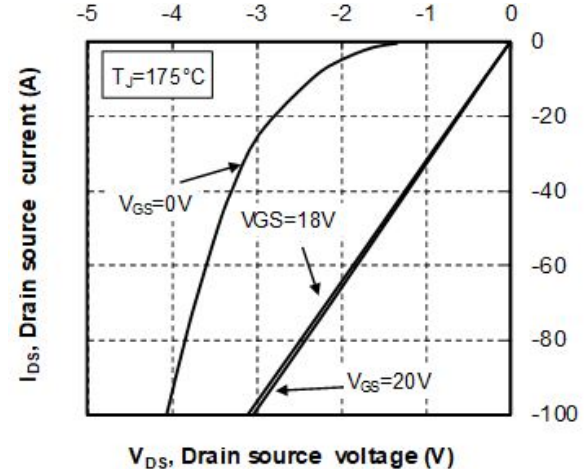
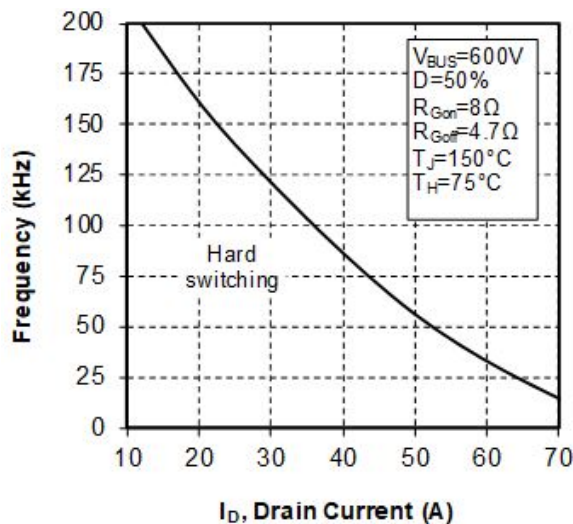




Figure 1-14. Operating Frequency vs Drain Current



1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM120DAM31CTBL1NG device.

Figure 1-15. Junction-to-Heatsink Thermal Impedance

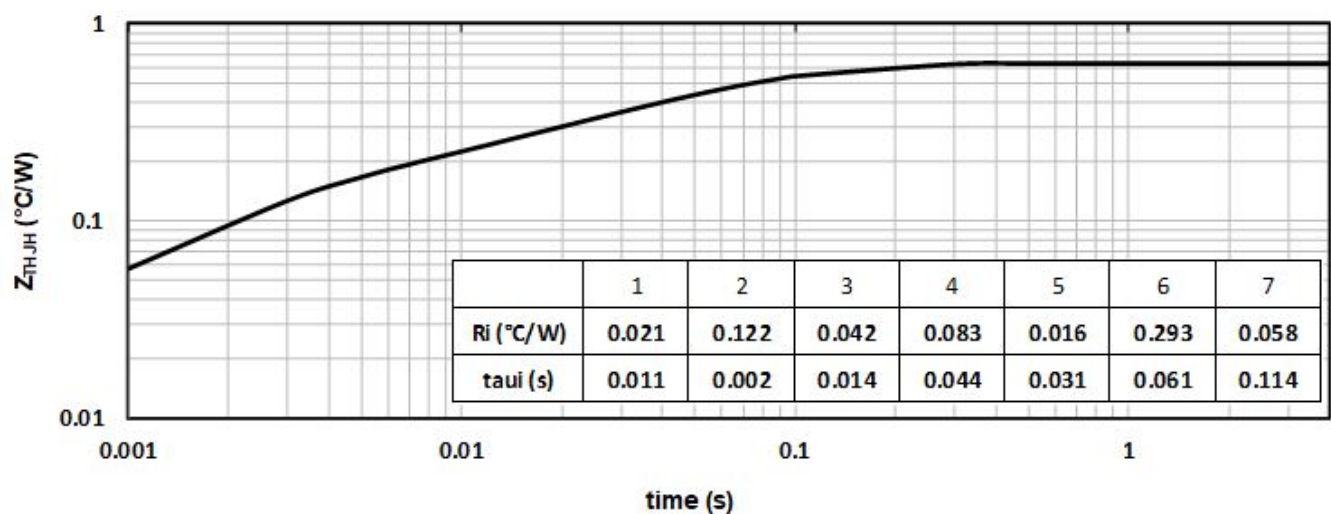


Figure 1-16. Forward Characteristics

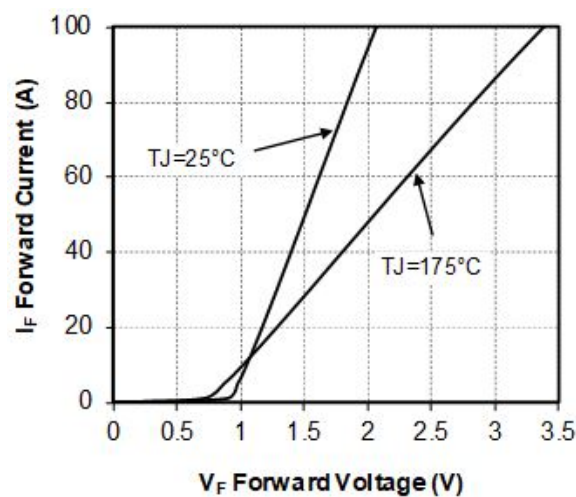
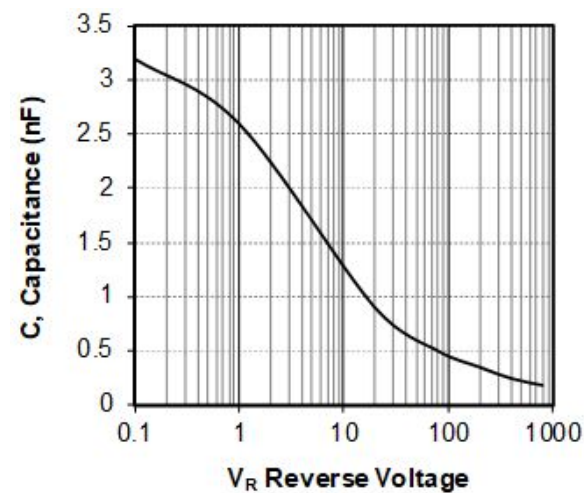


Figure 1-17. Capacitance vs. Reverse Voltage



The following section shows the package specification of the MSCSM120DAM31CTBL1NG device.

The following figure shows the package outline drawing of MSCSM120DAM31CTBL1NG device. The dimensions in the following figure are in millimeters.

**3. Revision History**

Revision	Date	Description
A	07/2021	Initial Revision

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