

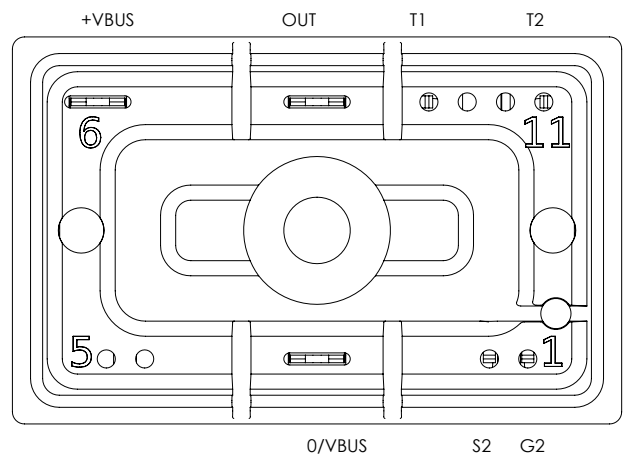
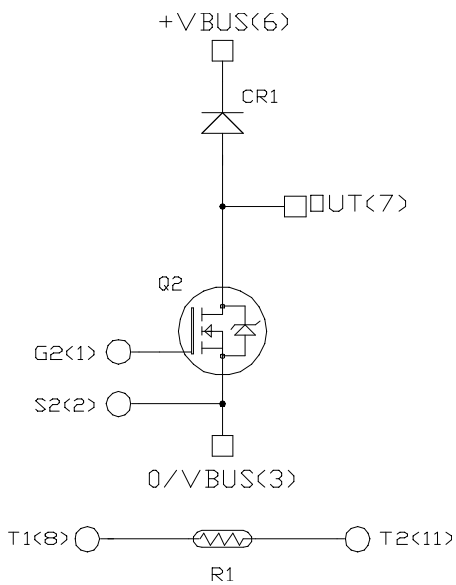
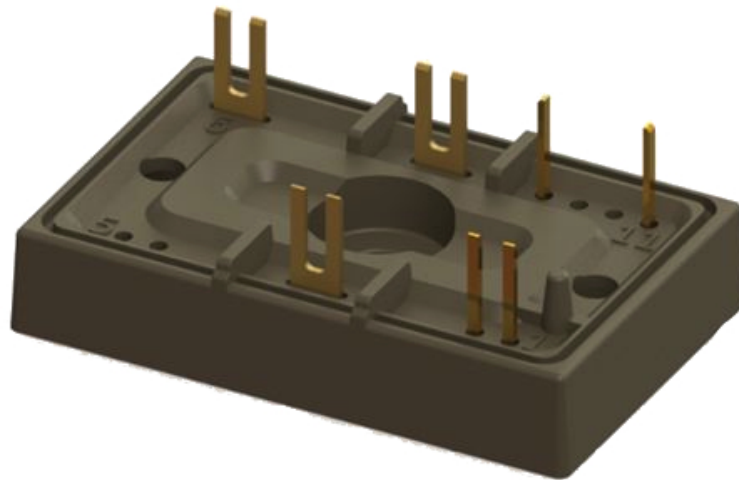


# MSCSM120DAM31CTBL1NG

## 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
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_H = 25\text{ }^\circ\text{C}$	79
		$T_H = 80\text{ }^\circ\text{C}$	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

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	

# MSCSM120DAM31CTBL1NG

## Electrical Specifications

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	T <sub>J</sub> = 150 °C	—	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	$V_R = 1200\text{ V}$	$T_J = 25\text{ }^\circ\text{C}$	—	10	200	$\mu\text{A}$
			$T_J = 175\text{ }^\circ\text{C}$	—	250	—	
$I_F$	DC forward current		$T_H = 100\text{ }^\circ\text{C}$	—	50	—	A
$V_F$	Diode forward voltage	$I_F = 50\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.1	—	
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$	—	224	—	nC	
C	Total capacitance	$f = 1\text{ MHz}$ $V_R = 400\text{ V}$	—	246	—	pF	
		$f = 1\text{ MHz}$ $V_R = 800\text{ V}$	—	182	—		
$R_{thJH}$	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
Wt	Package weight	—	13.5	—	g	

# MSCSM120DAM31CTBL1NG

## Electrical Specifications

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	—	%

$$R_T = \frac{R_{25}}{\exp \left[ B_{25/85} \left( \frac{1}{T_{25}} - \frac{1}{T} \right) \right]}$$

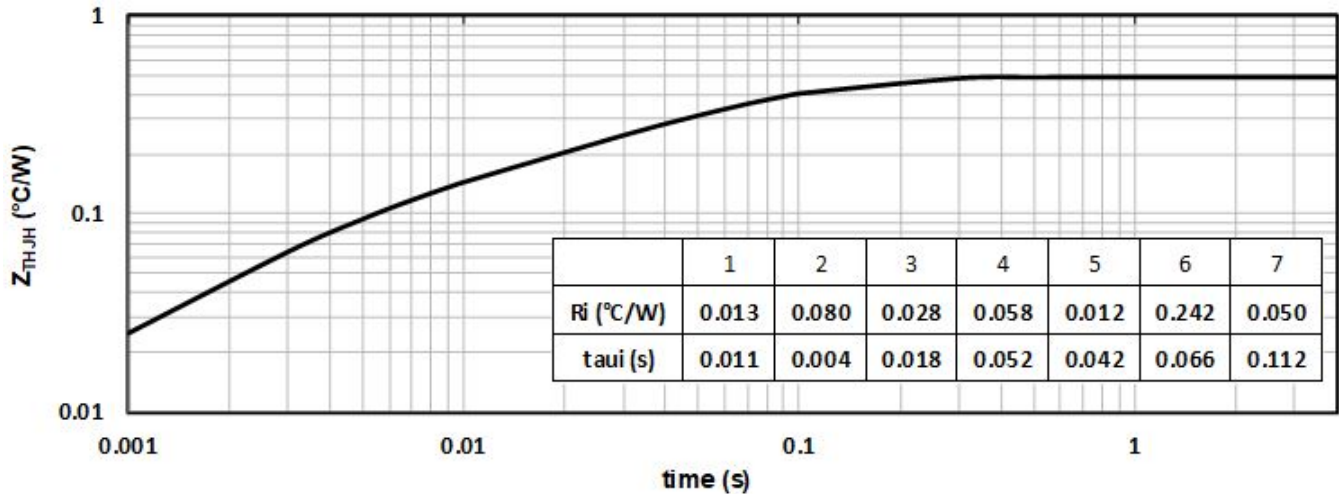
T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

**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**



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## Electrical Specifications

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

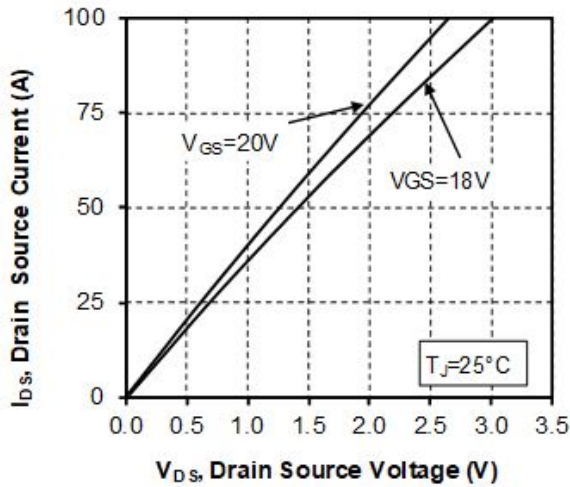


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

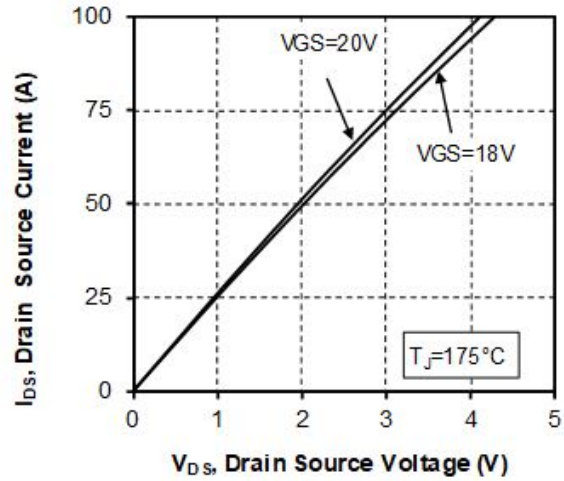


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

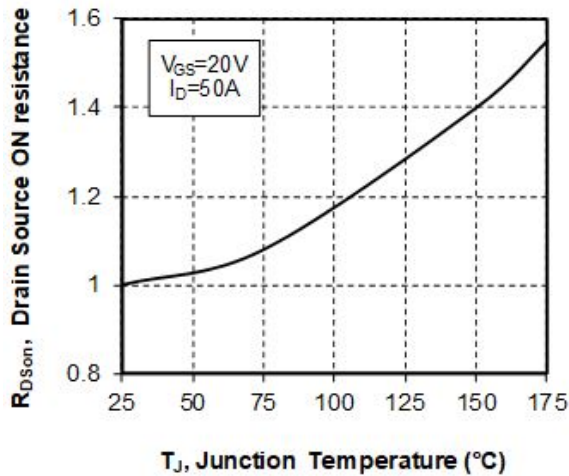


Figure 1-5. Transfer Characteristics

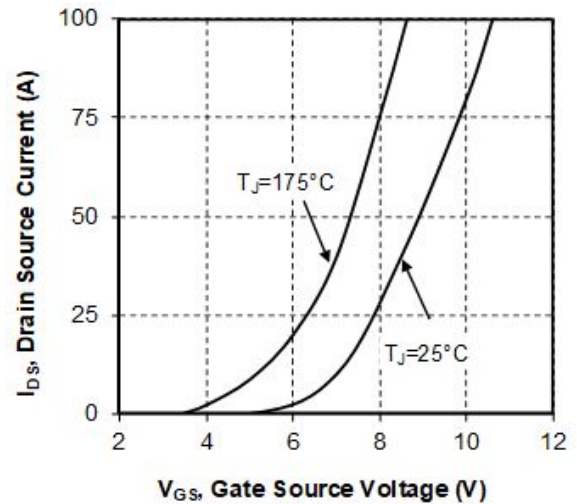


Figure 1-6. Switching Energy vs.  $R_g$

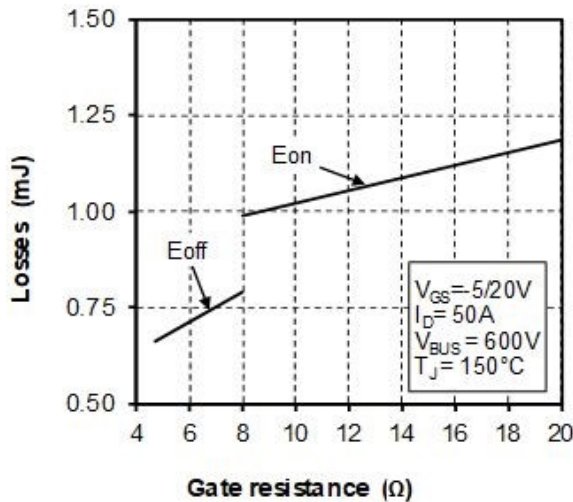
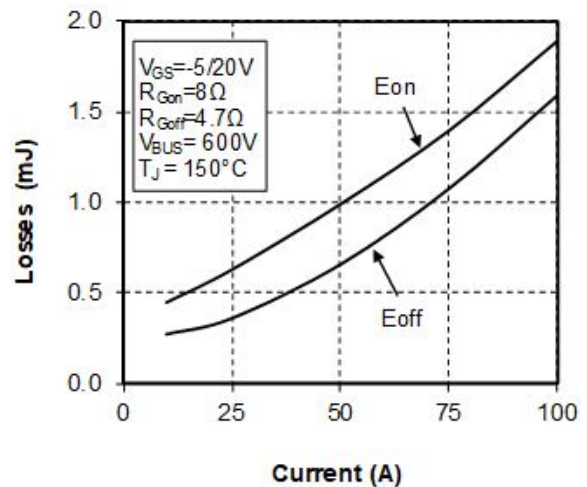


Figure 1-7. Switching Energy vs. Current



# MSCSM120DAM31CTBL1NG

## Electrical Specifications

Figure 1-8. Capacitance vs. Drain Source Voltage

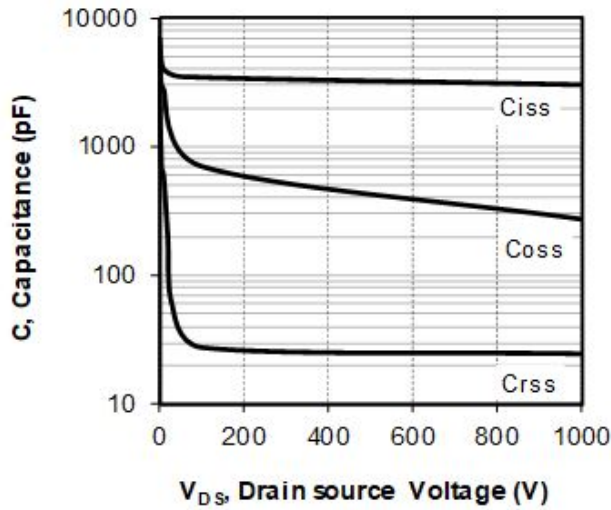


Figure 1-9. Gate Charge vs. Gate Source Voltage

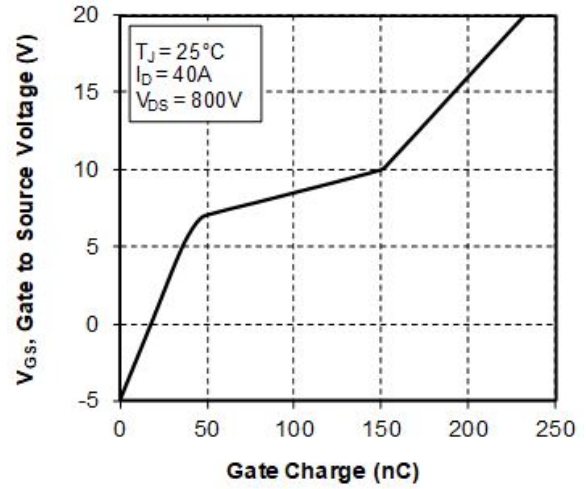


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

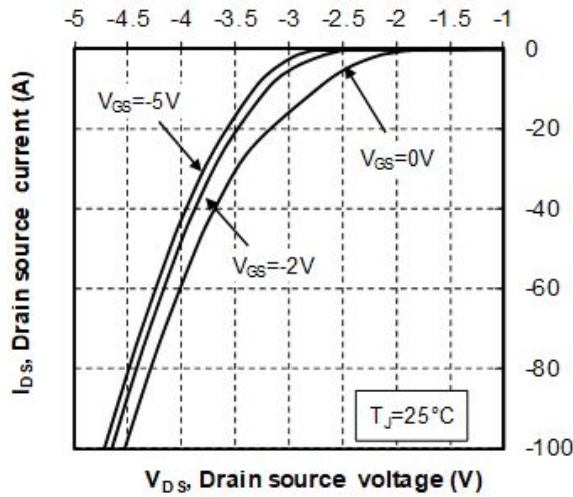


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

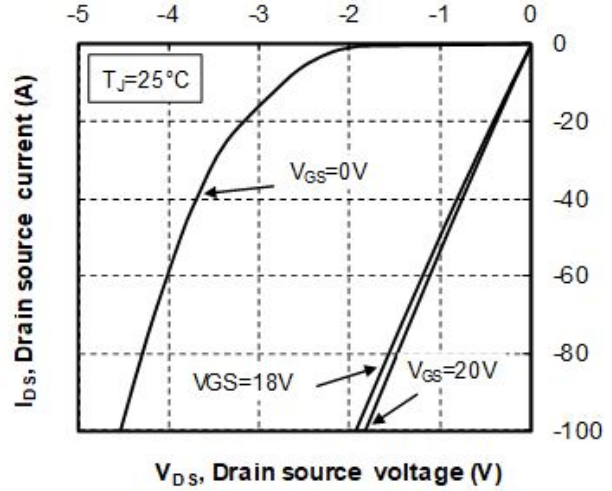


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

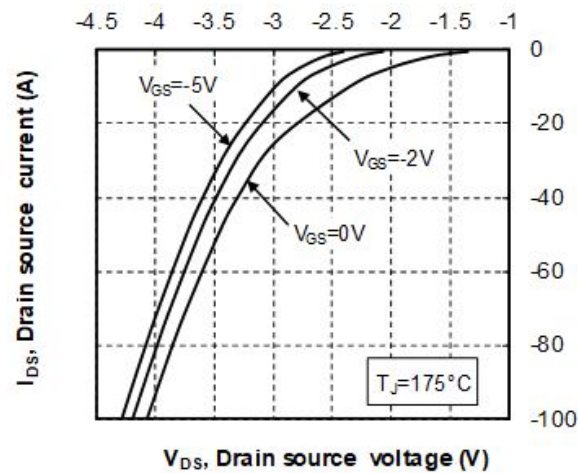
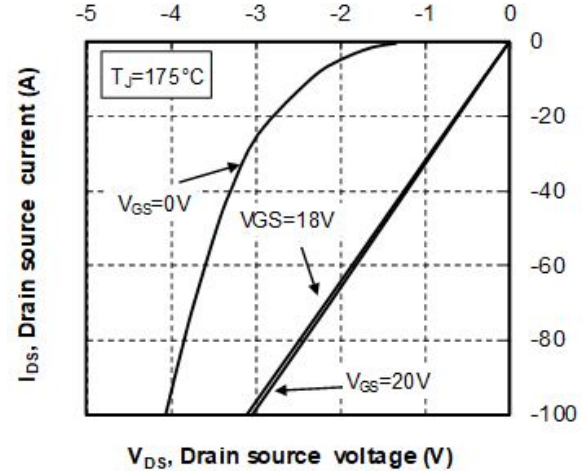
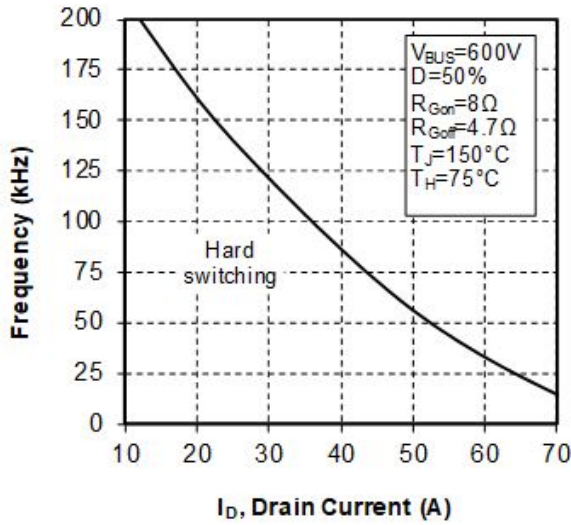


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$





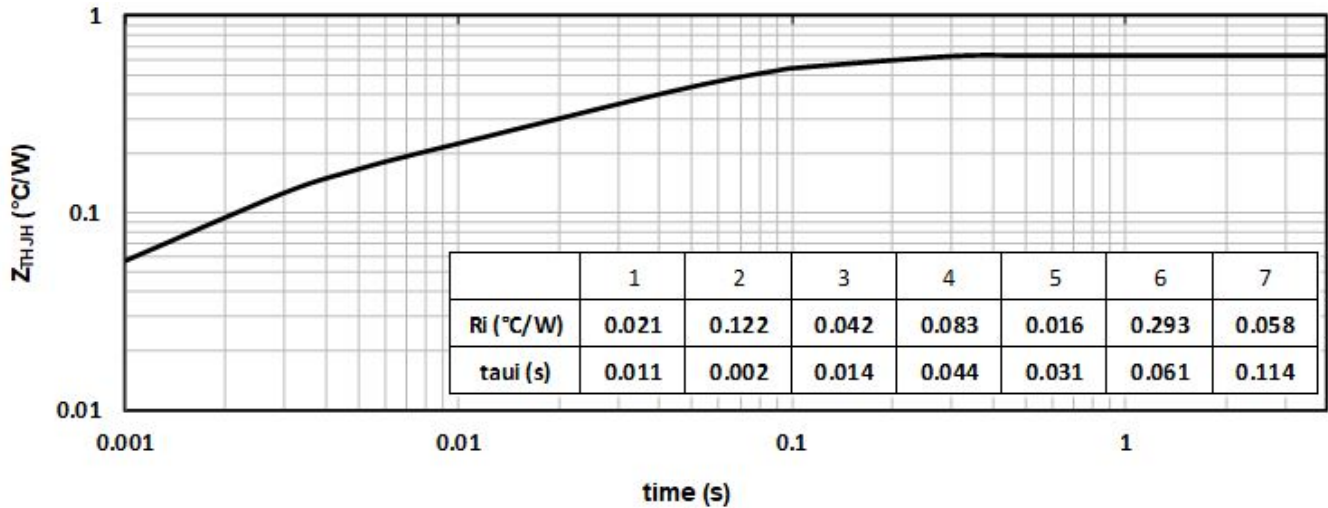
**Figure 1-14. Operating Frequency vs Drain Current**



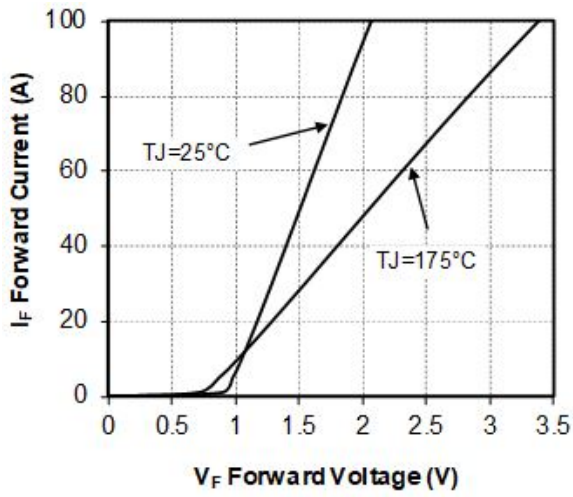
**1.5 Typical SiC Diode Performance Curves (Per SiC Diode)**

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

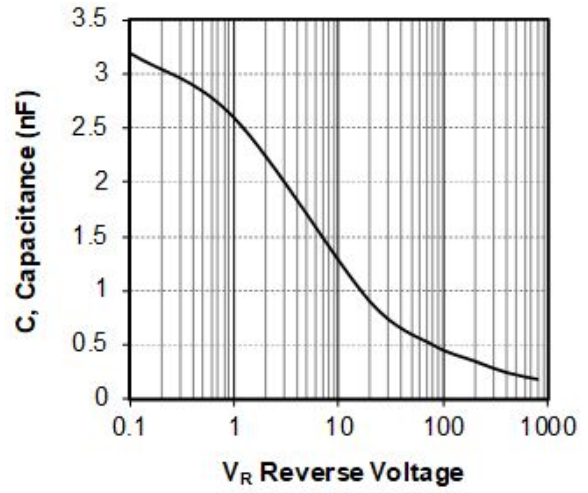
**Figure 1-15. Junction-to-Heatsink Thermal Impedance**



**Figure 1-16. Forward Characteristics**



**Figure 1-17. Capacitance vs. Reverse Voltage**



# MSCSM120DAM31CTBL1NG

## Package Specifications

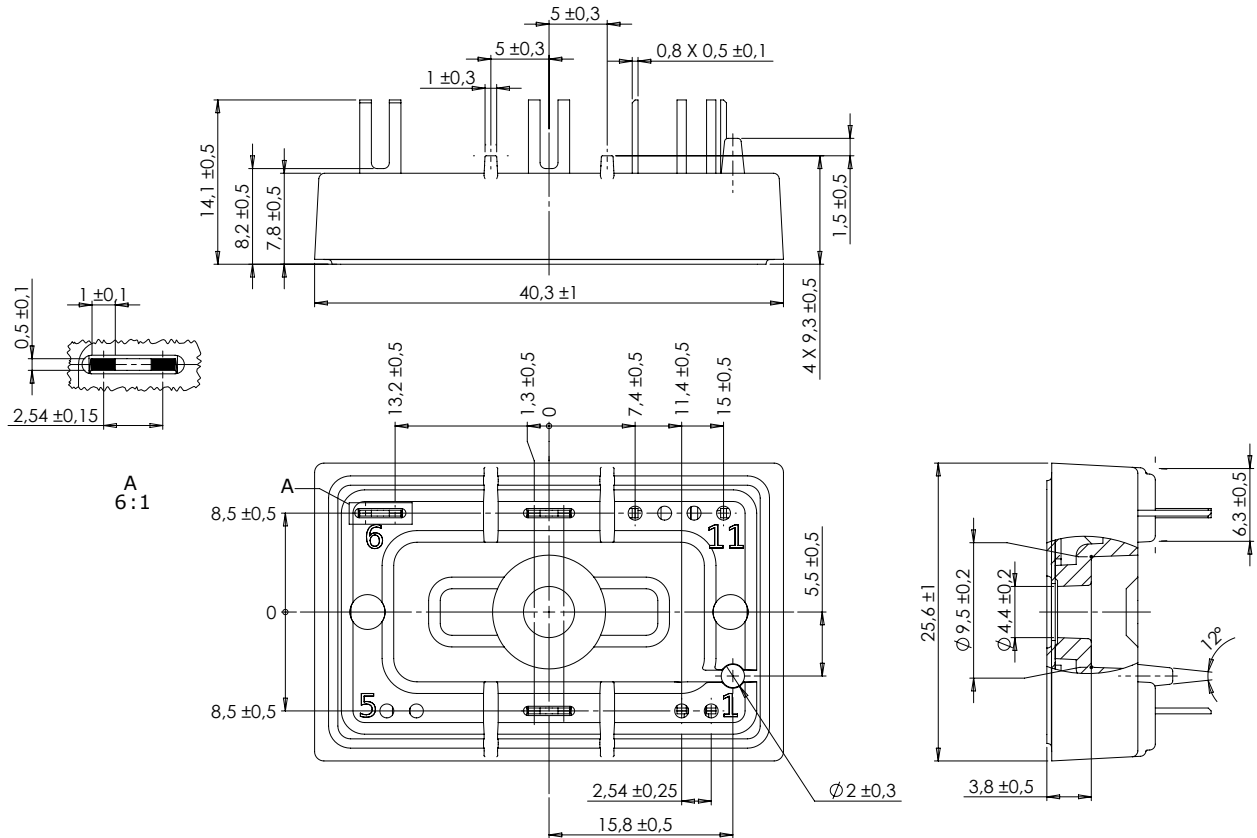
## 2. Package Specifications

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

### 2.1 Package Outline

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

**Figure 2-1. Package Outline Drawing**



### 3. Revision History

Revision	Date	Description
A	07/2021	Initial Revision

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