

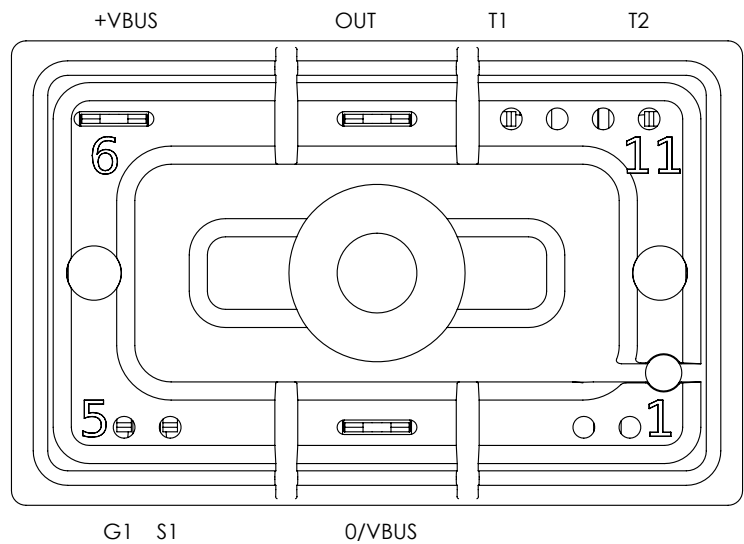
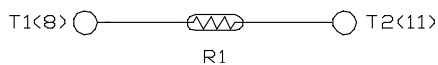
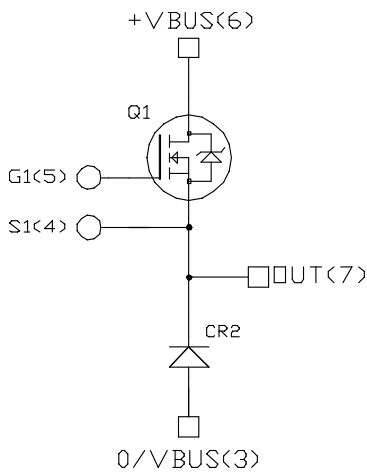
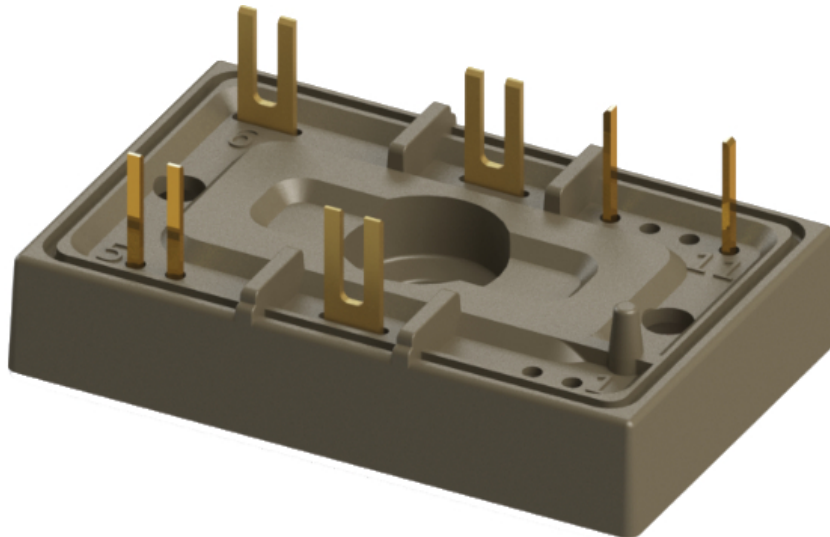


MSCSM120SKM31CTBL1NG

Buck Chopper SiC MOSFET Power Module

Product Overview

The MSCSM120SKM31CTBL1NG device is a 1200 V, 79 A buck 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

The following are the key features of MSCSM120SKM31CTBL1NG 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

The following are the benefits of MSCSM120SKM31CTBL1NG device:

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

Application

The following are the applications of MSCSM120SKM31CTBL1NG 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 MSCSM120SKM31CTBL1NG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of MSCSM120SKM31CTBL1NG 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 Ω
P_D	Power dissipation	$T_H = 25\text{ }^\circ\text{C}$	310

The following table lists the electrical characteristics of MSCSM120SKM31CTBL1NG 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	μA	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$	$T_J = 25\text{ }^\circ\text{C}$	—	25	31	m Ω
			$T_J = 175\text{ }^\circ\text{C}$	—	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	

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The following table lists the dynamic characteristics of MSCSM120SKM31CTBL1NG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C _{iss}	Input capacitance	V _{GS} = 0 V	—	3020	—	pF
C _{oss}	Output capacitance	V _{DS} = 1000 V	—	270	—	
C _{rss}	Reverse transfer capacitance	f = 1 MHz	—	25	—	
Q _g	Total gate charge	V _{GS} = -5 V/20 V	—	232	—	nC
Q _{gs}	Gate-Source charge	V _{Bus} = 800 V	—	41	—	
Q _{gd}	Gate-Drain charge	I _D = 40 A	—	50	—	
T _{d(on)}	Turn-on delay time	V _{GS} = -5 V/20 V	—	30	—	ns
T _r	Rise time	V _{Bus} = 600 V	—	30	—	
T _{d(off)}	Turn-off delay time	I _D = 50 A	—	50	—	
T _f	Fall time	R _{Gon} = 8 Ω R _{Goff} = 4.7 Ω	—	25	—	
E _{on}	Turn-on energy	V _{GS} = -5 V/20 V	T _J = 150 °C	—	0.99	mJ
E _{off}	Turn-off energy	V _{Bus} = 600 V I _D = 50 A R _{Gon} = 8 Ω R _{Goff} = 4.7 Ω	T _J = 150 °C	—	0.66	
R _{Gint}	Internal gate resistance		—	0.88	—	Ω
R _{thJH}	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 MSCSM120SKM31CTBL1NG 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} = 40 A	—	4	—	V
		V _{GS} = -5 V I _{SD} = 40 A	—	4.2	—	
t _{rr}	Reverse recovery time	I _{SD} = 40 A	—	90	—	ns
Q _{rr}	Reverse recovery charge	V _{GS} = -5 V	—	550	—	nC
I _{rr}	Reverse recovery current	V _R = 800 V di _F /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 MSCSM120SKM31CTBL1NG 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	μA
			$T_J = 175\text{ }^\circ\text{C}$	—	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 MSCSM120SKM31CTBL1NG 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		

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The following table lists the temperature sensor NTC of the MSCSM120SKM31CTBL1NG device.

Table 1-7. Temperature Sensor NTC

Symbol	Characteristic	Min	Typ	Max	Unit
R ₂₅	Resistance at 25°C	—	50	—	kΩ
ΔR ₂₅ /R ₂₅	—	—	5	—	%
B _{25/85}	T ₂₅ = 298.15 K	—	3952	—	K
ΔB/B	—	T _C = 100°C	4	—	%

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

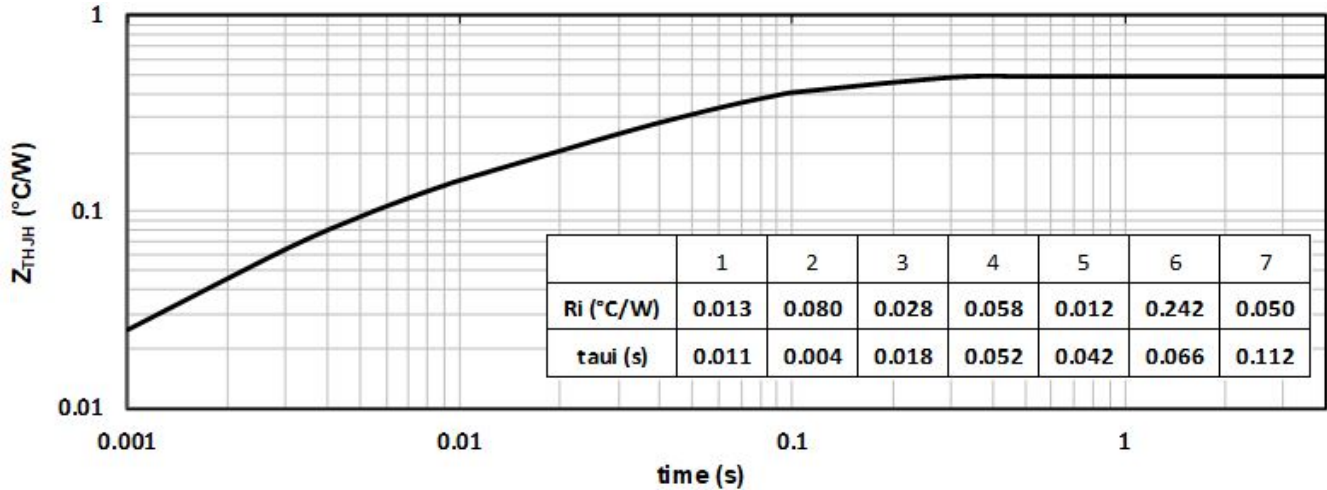
T: Thermistor temperature
R_T: Thermistor value at T

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

1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120SKM31CTBL1NG device.

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



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Electrical Specifications

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

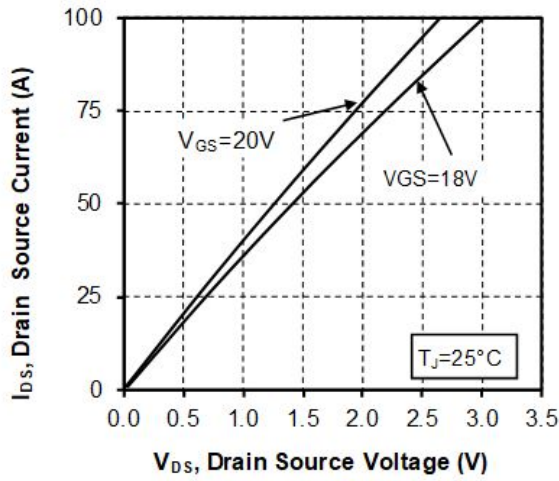


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

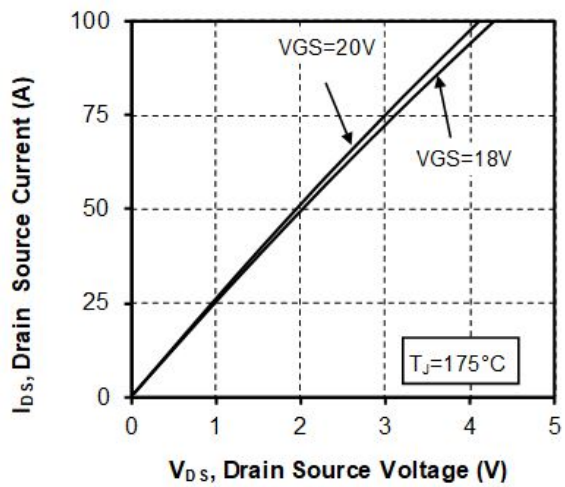


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

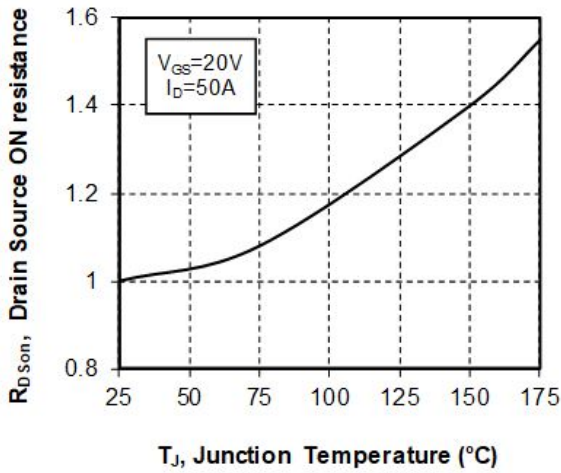


Figure 1-5. Transfer Characteristics

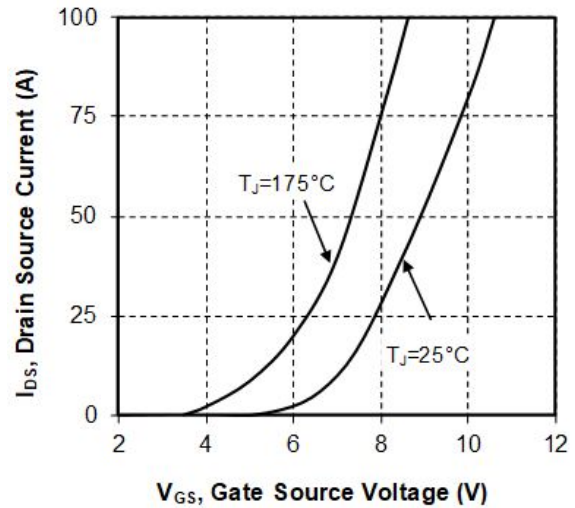


Figure 1-6. Switching Energy vs. R_g

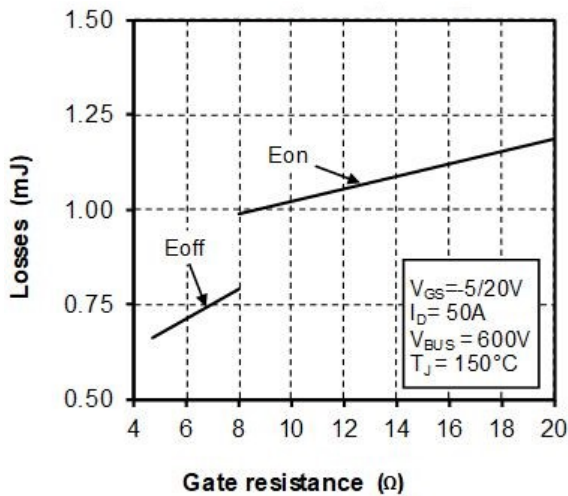


Figure 1-7. Switching Energy vs. Current

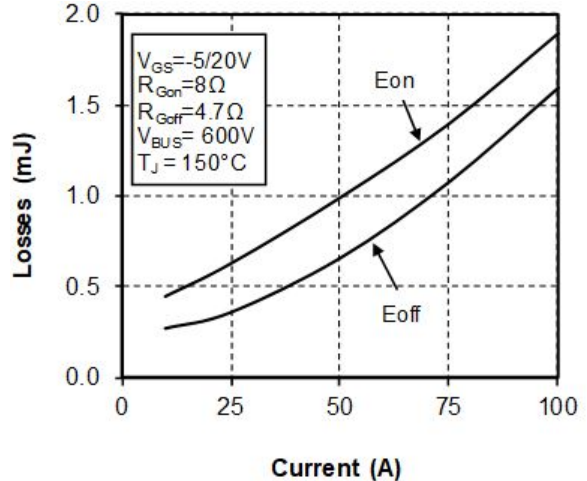


Figure 1-8. Capacitance vs. Drain Source Voltage

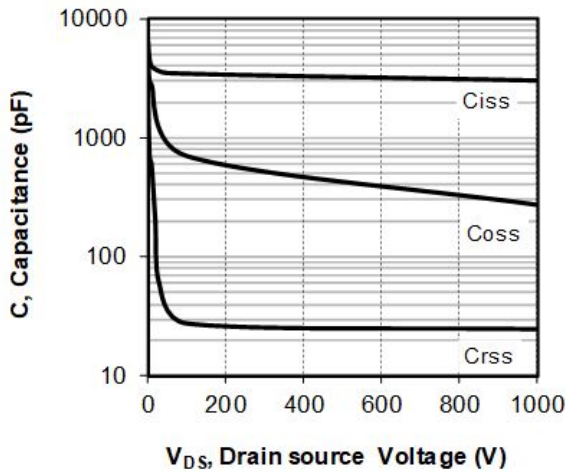


Figure 1-9. Gate Charge vs. Gate Source Voltage

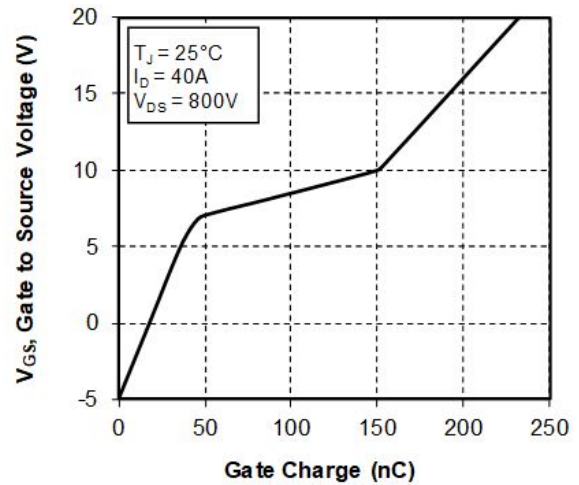


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

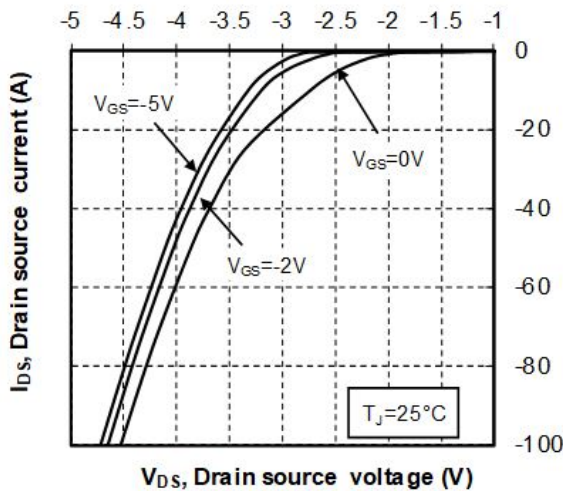


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

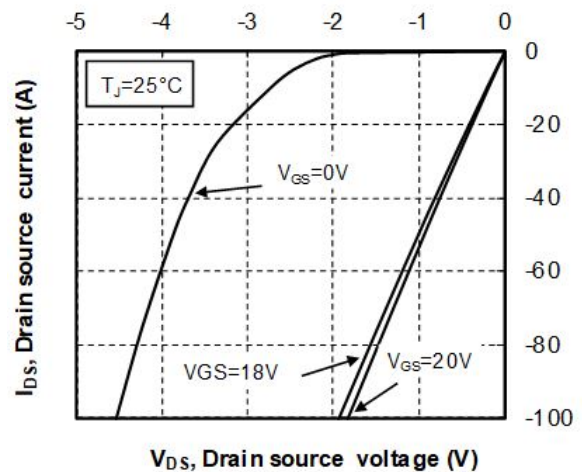


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

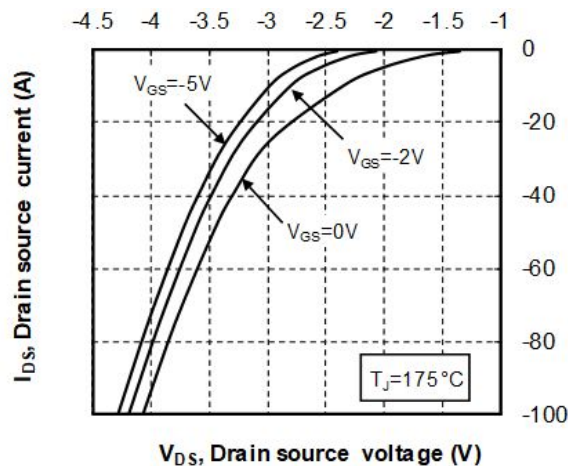


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

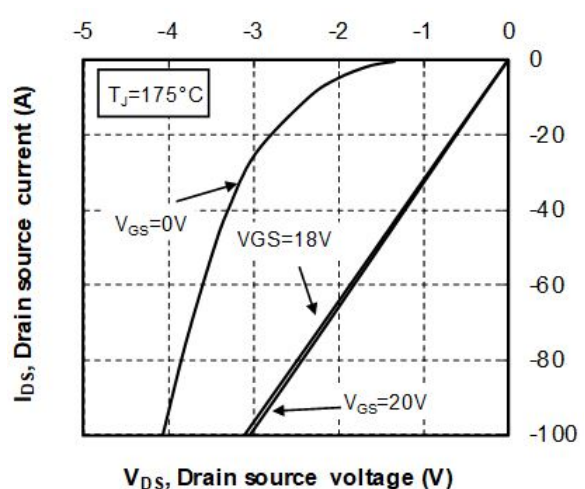
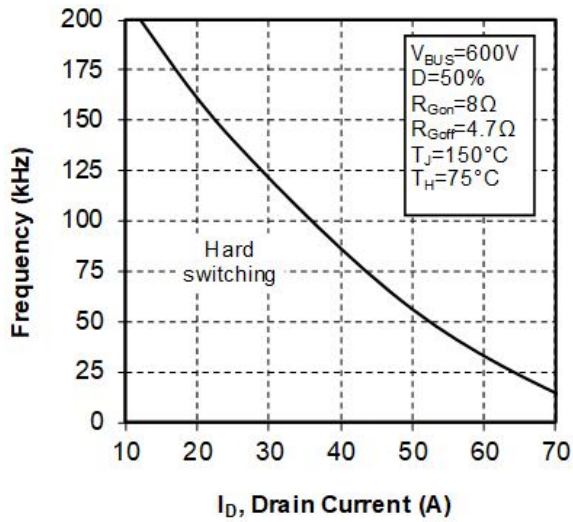


Figure 1-14. Operating Frequency vs Drain Current



1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM120SKM31CTBL1NG device.

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

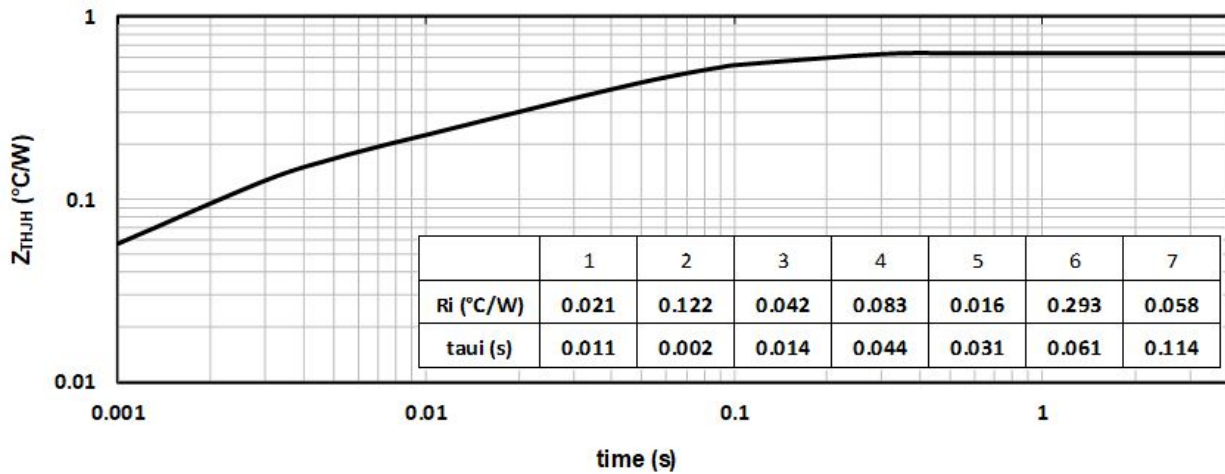


Figure 1-16. Forward Characteristics

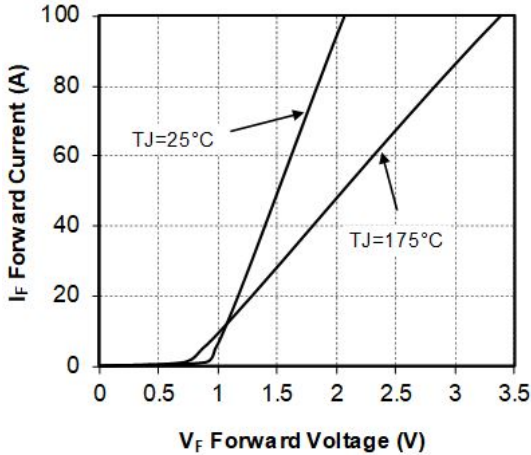
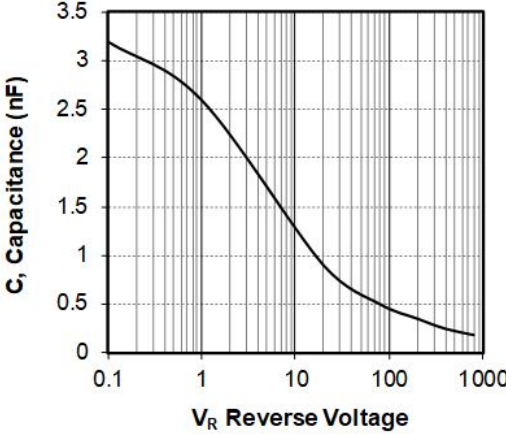


Figure 1-17. Capacitance vs. Reverse Voltage



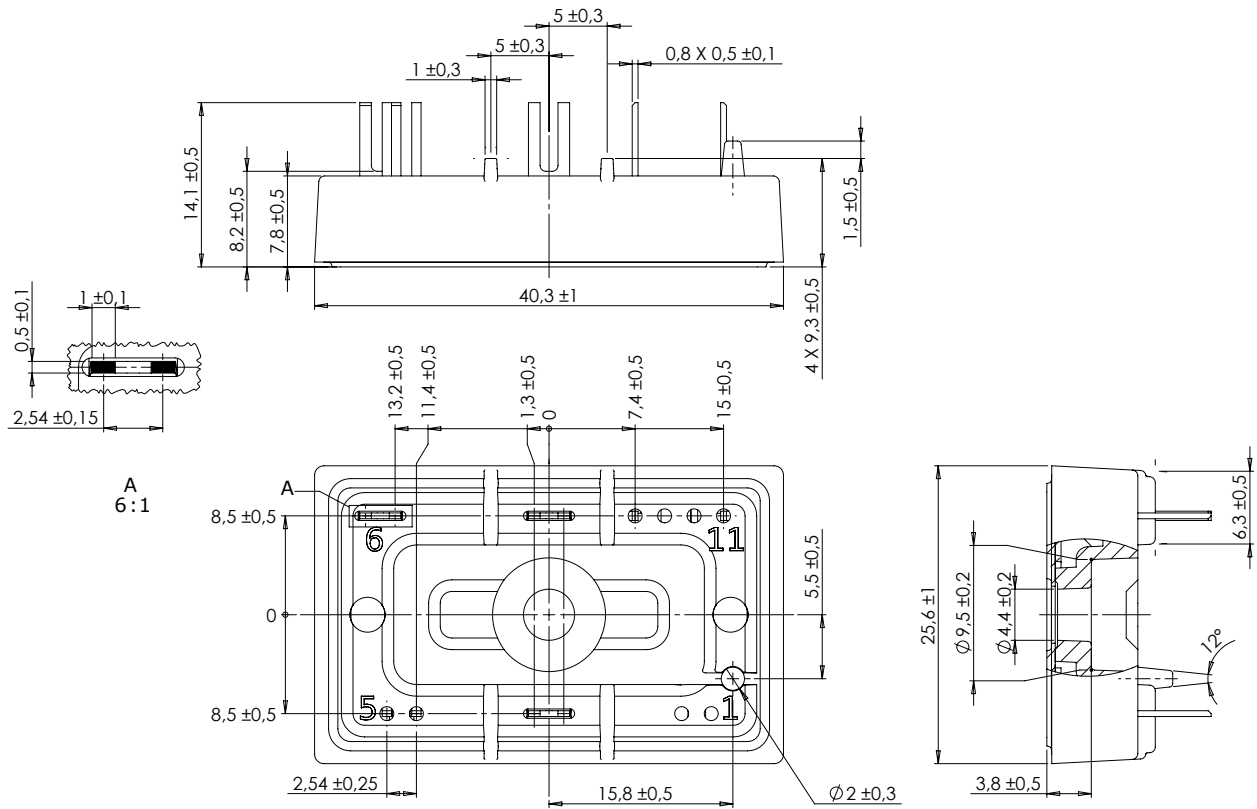
2. Package Specifications

The following section shows the package specification of the MSCSM120SKM31CTBL1NG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120SKM31CTBL1NG 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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ISBN: 978-1-5224-8531-5

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