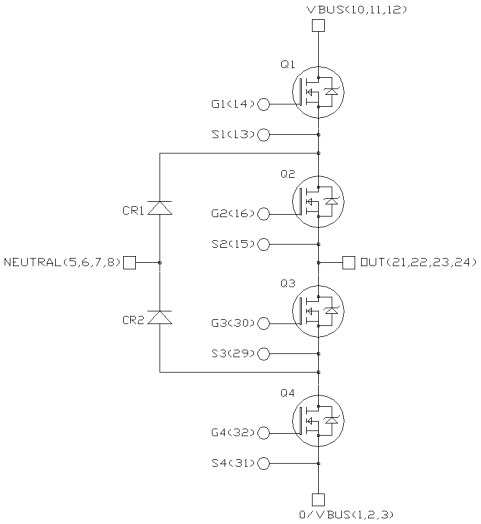
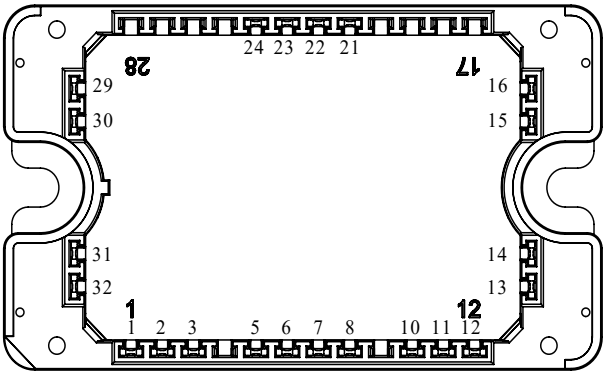
MSCSM120TLM31C3AG

Three Level Inverter SiC MOSFET Power Module

Product Overview

The MSCSM120TLM31C3AG device is a 1200V/89A three level inverter silicon carbide (SiC) MOSFET power module.





Note:

1. All ratings at T_J = 25 °C, unless otherwise specified.
2. All multiple inputs and outputs must be shorted together: 1/2/3 ; 10/11/12 ; 5/6/7/8 ; 21/22/23/24

⚠ CAUTION These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

Features

The following are the key features of MSCSM120TLM31C3AG device:

- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- SiC Schottky Diode (CR1 and CR2)
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF
- Kelvin source for easy drive
- Low stray inductance
- High level of integration
- AlN substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM120TLM31C3AG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS compliant

Application

The following are the applications of MSCSM120TLM31C3AG device:

- Uninterruptible power supplies

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120TLM31C3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of MSCSM120TLM31C3AG 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_C = 25 °C	89	A
		T_C = 80 °C	71	
I_{DM}	Pulsed drain current		180	
V_{GSmax}	Gate-Source voltage		–10/25	V
$R_{DS(on)}$	Drain-Source ON resistance		31	mΩ
P_D	Power dissipation	T_C = 25 °C	395	W

The following table lists the electrical characteristics of MSCSM120TLM31C3AG device.

Table 1-2. Electrical Characteristics

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

The following table lists the dynamic characteristics of MSCSM120TLM31C3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V V_{DS} = 1000V f = 1 MHz		—	3020	—	pF
C_{oss}	Output capacitance			—	270	—	
C_{rss}	Reverse transfer capacitance			—	25	—	
Q_g	Total gate charge	V_{GS} = –5V/20V V_{Bus} = 800V I_D = 40A		—	232	—	nC
Q_{gs}	Gate-Source charge			—	41	—	
Q_{gd}	Gate-Drain charge			—	50	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V V_{Bus} = 800V I_D = 50A R_{Gon} = 8Ω R_{Goff} = 4.7Ω		—	30	—	ns
T_r	Rise time			—	30	—	
$T_{d(off)}$	Turn-off delay time			—	50	—	
T_f	Fall time				25	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V V_{Bus} = 600V I_D = 50A R_{Gon} = 8Ω R_{Goff} = 4.7Ω	T_J = 150 °C	—	0.99	—	mJ
E_{off}	Turn-off energy		T_J = 150 °C	—	0.66	—	
R_{Gint}	Internal gate resistance			—	0.88	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.38	°C/W

The following table lists the body diode ratings and characteristics of MSCSM120TLM31C3AG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0V I_{SD} = 40A	—	4	—	V
		V_{GS} = –5V I_{SD} = 40A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 40A V_{GS} = –5V V_R = 800V di_F/dt = 1000 A/µs	—	90	—	ns
Q_{rr}	Reverse recovery charge		—	550	—	nC
I_{rr}	Reverse recovery current		—	13.5	—	A

1.2 CR1 and CR2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the CR1 and CR2 SiC diode ratings and characteristics (per SiC diode) of MSCSM120TLM31C3AG device.

Table 1-5. CR1 and CR2 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 V	T_J = 25 °C	—	15	200	µA
			T_J = 175 °C	—	250	—	
I_F	DC forward current		T_C = 100 °C	—	50	—	A
V_F	Diode forward voltage	I_F = 50 A	T_J = 25 °C	—	1.5	1.8	V
			T_J = 175 °C	—	2.1	—	
Q_C	Total capacitive charge	V_R = 600 V		—	224	—	nC
C	Total capacitance	f = 1 MHz V_R = 400 V		—	246	—	pF
		f = 1 MHz V_R = 800 V		—	182	—	
R_{thJH}	Junction-to-heatsink thermal resistance			—	—	0.56	°C/W

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120TLM31C3AG 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	M4	2	3	N.m
Wt	Package weight			—	110	g

1.4 Typical SiC MOSFET Performance Curve (Per SiC MOSFET)

This section shows the typical SiC MOSFET performance curves of the MSCSM120TLM31C3AG device.

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

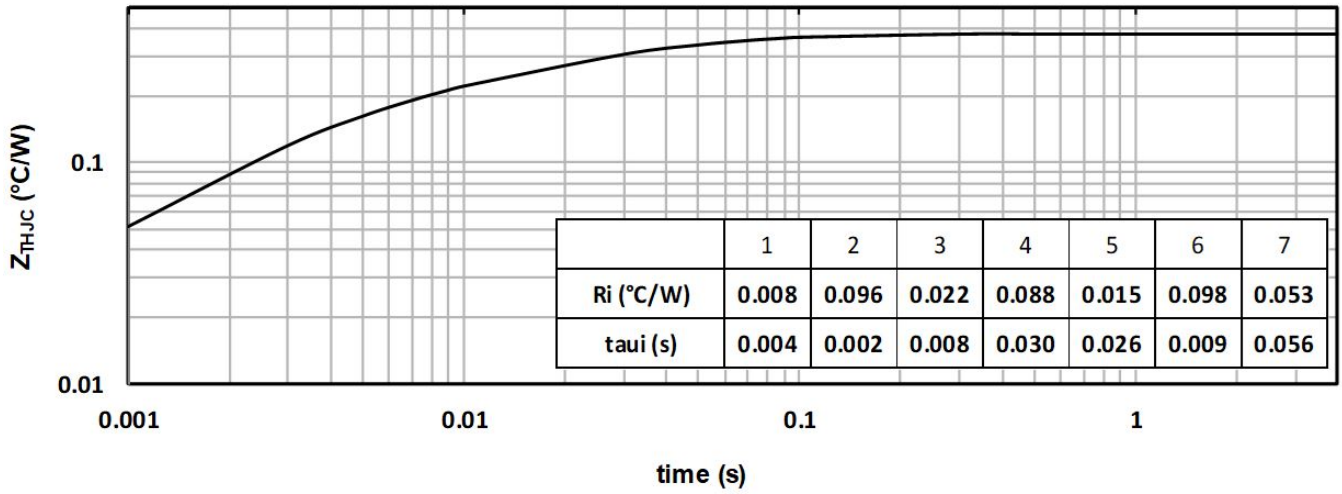


Figure 1-2. Output Characteristics, T_J = 25 °C

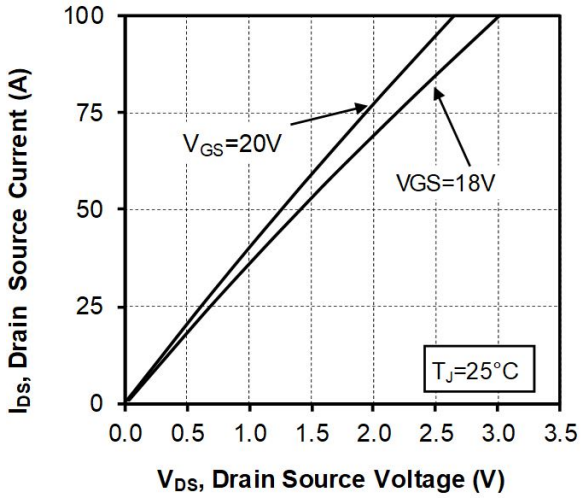


Figure 1-3. Output Characteristics, T_J = 175 °C

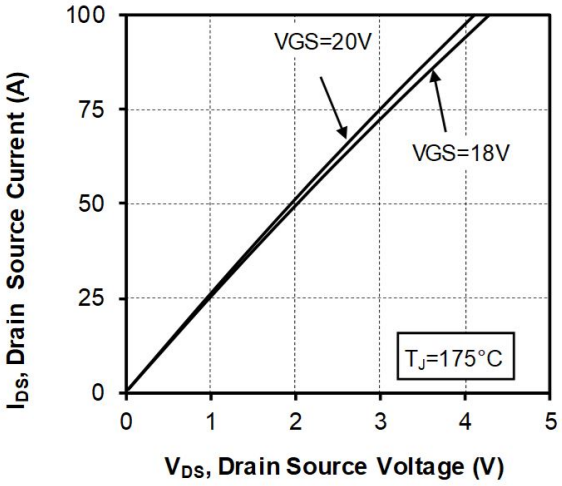


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

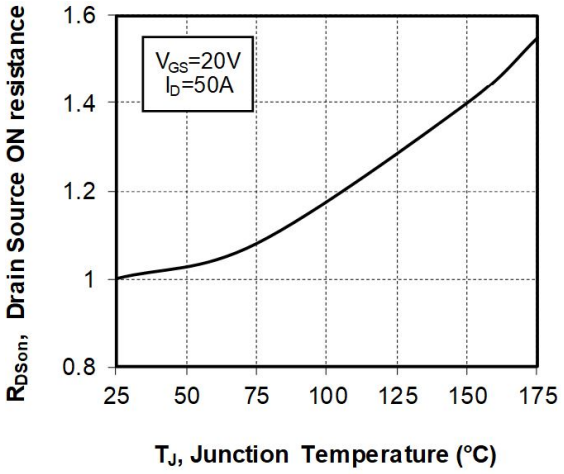


Figure 1-5. Transfer Characteristics

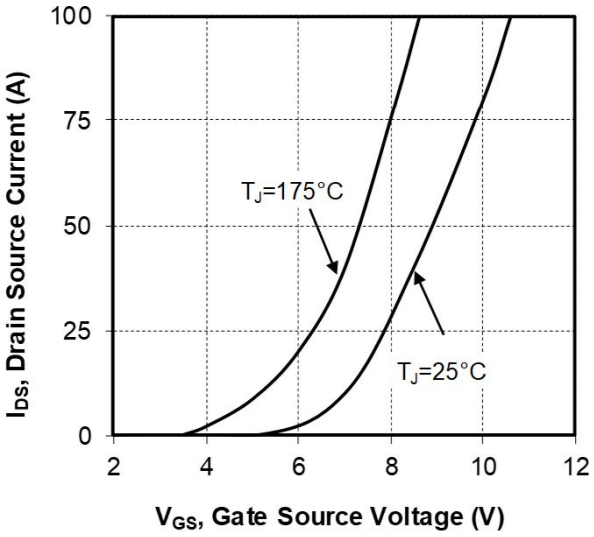


Figure 1-6. Switching Energy vs. Rg

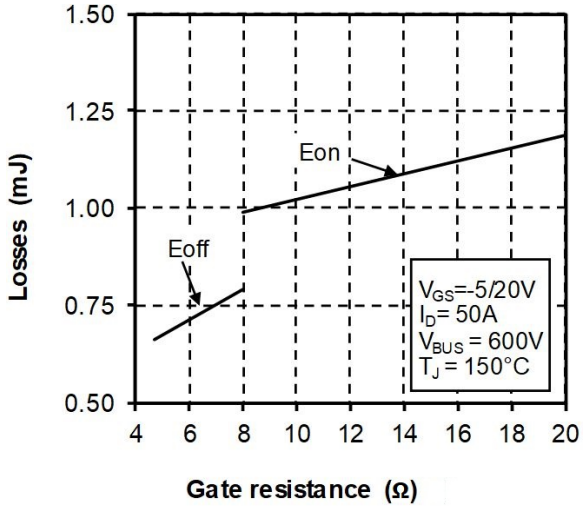


Figure 1-7. Switching Energy vs. Current

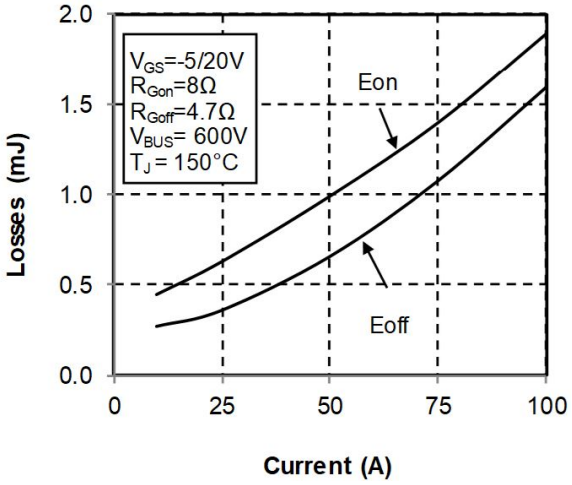


Figure 1-8. Capacitance vs. Drain Source Voltage

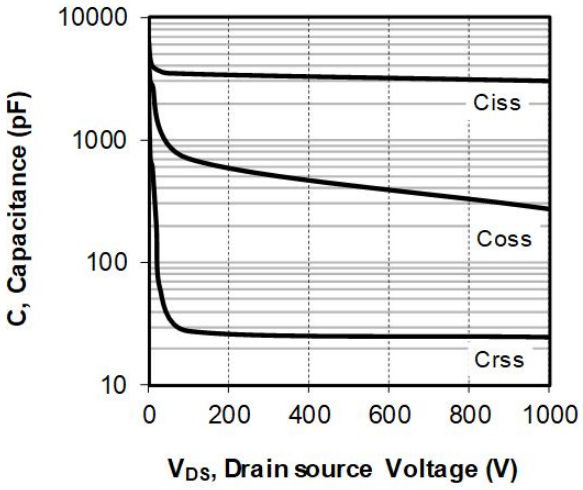


Figure 1-9. Gate Charge vs. Gate Source Voltage

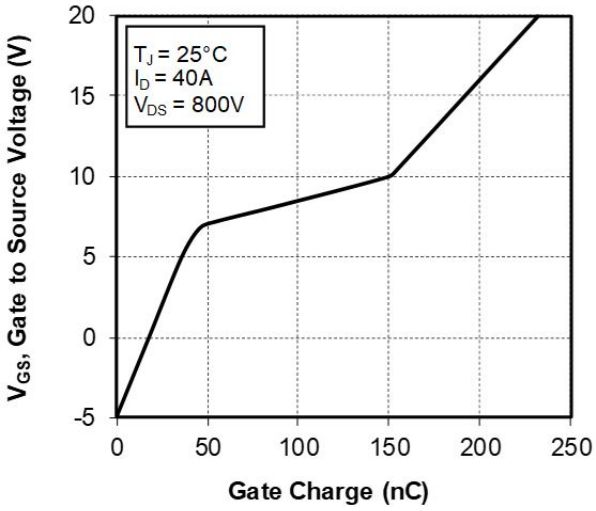


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

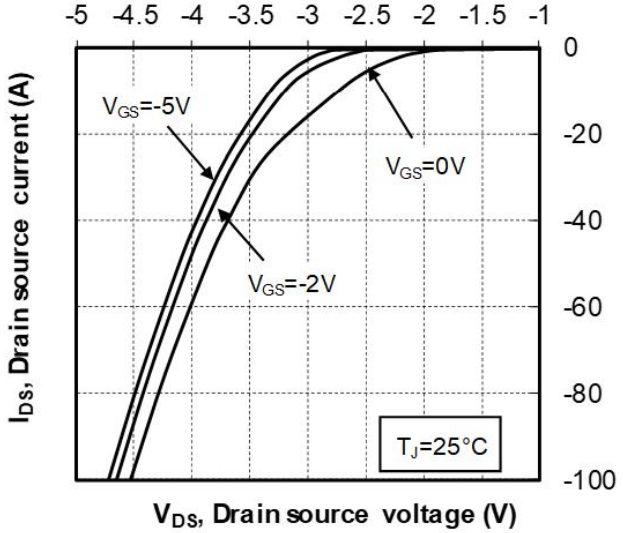


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

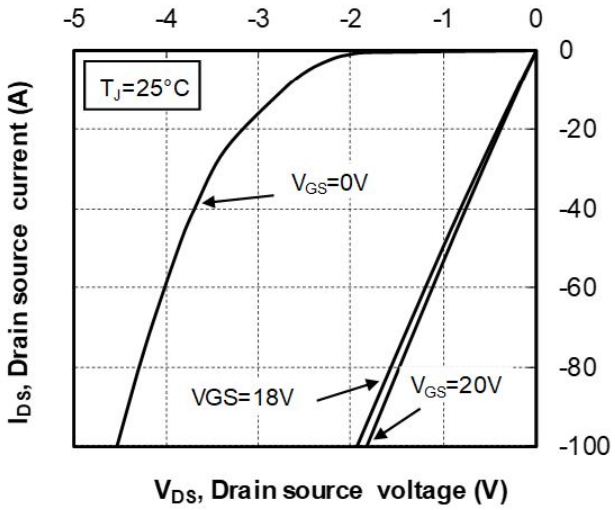


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

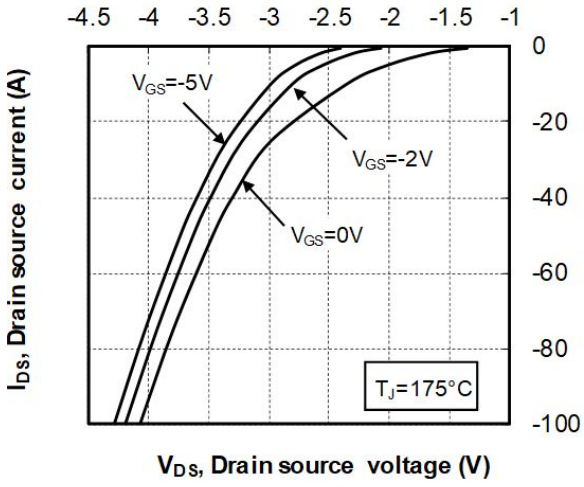


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

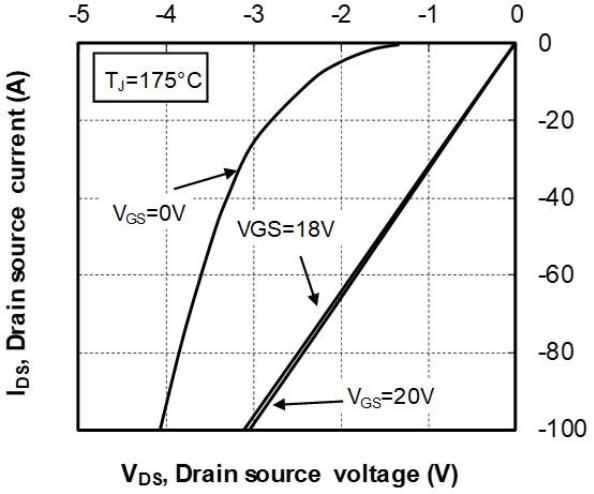
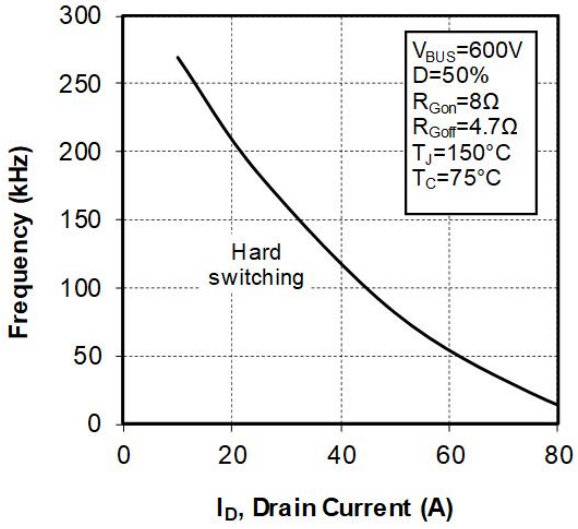


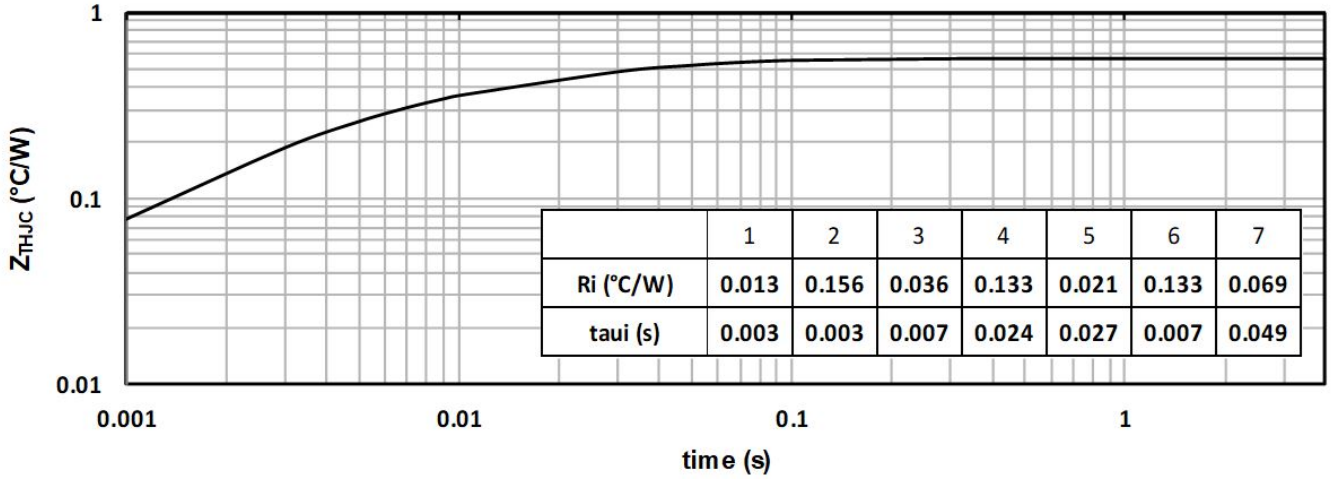
Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM120TLM31C3AG device.

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



	1	2	3	4	5	6	7
Ri (°C/W)	0.013	0.156	0.036	0.133	0.021	0.133	0.069
taui (s)	0.003	0.003	0.007	0.024	0.027	0.007	0.049

Figure 1-16. Forward Characteristics

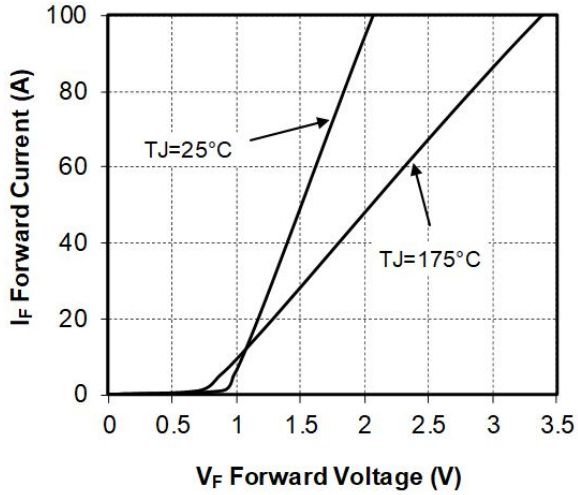
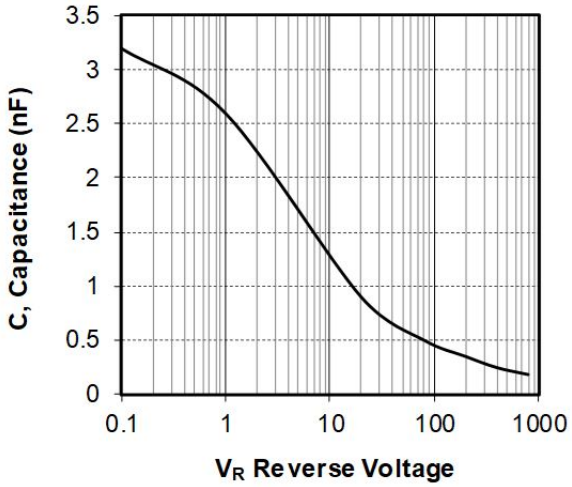


Figure 1-17. Capacitance vs. Reverse Voltage



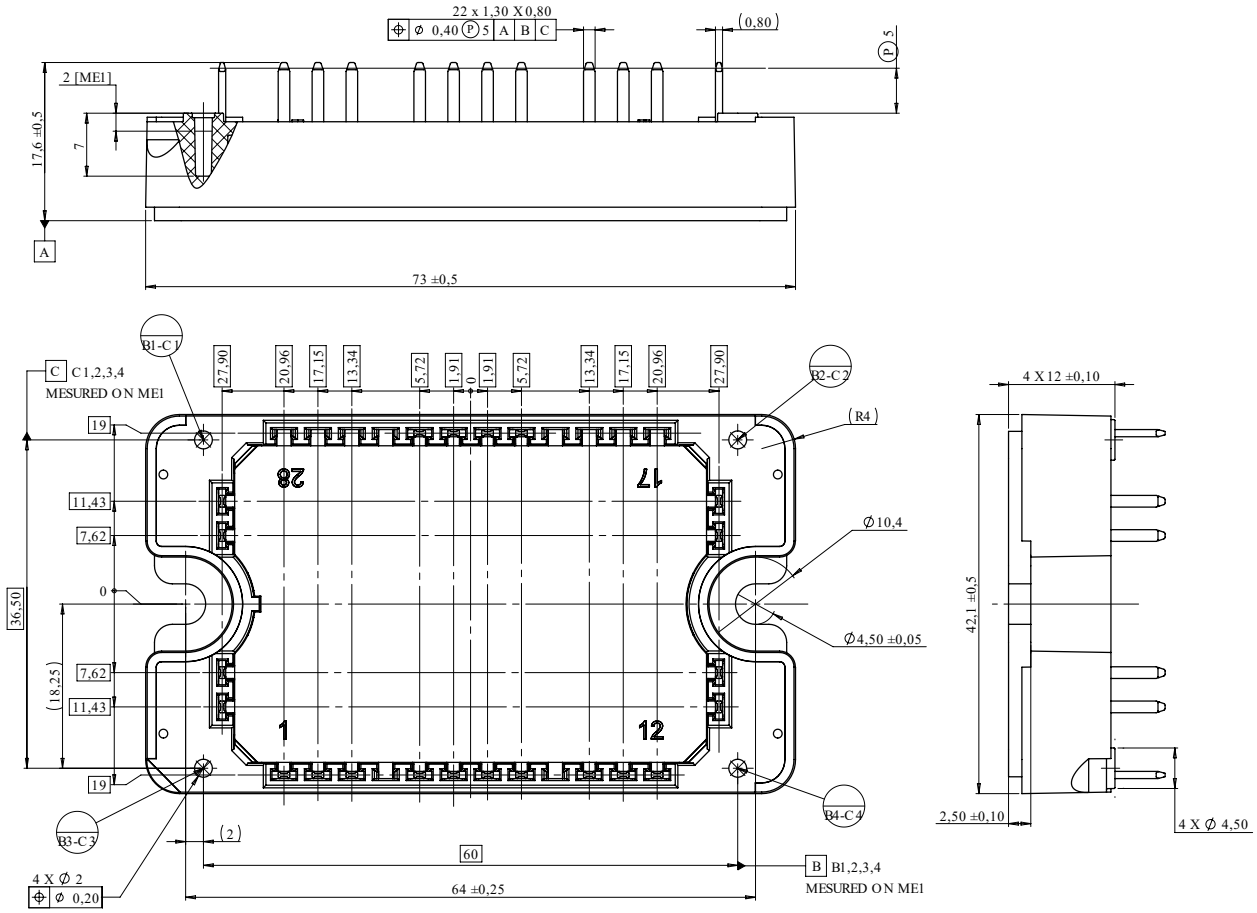
2. Package Specifications

The following section shows the package specification of the device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120TLM31C3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See application note AN3500A—Mounting instructions for SP1F and SP3F power modules.

3. Revision History

Revision	Date	Description
A	12/2021	Initial Revision

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