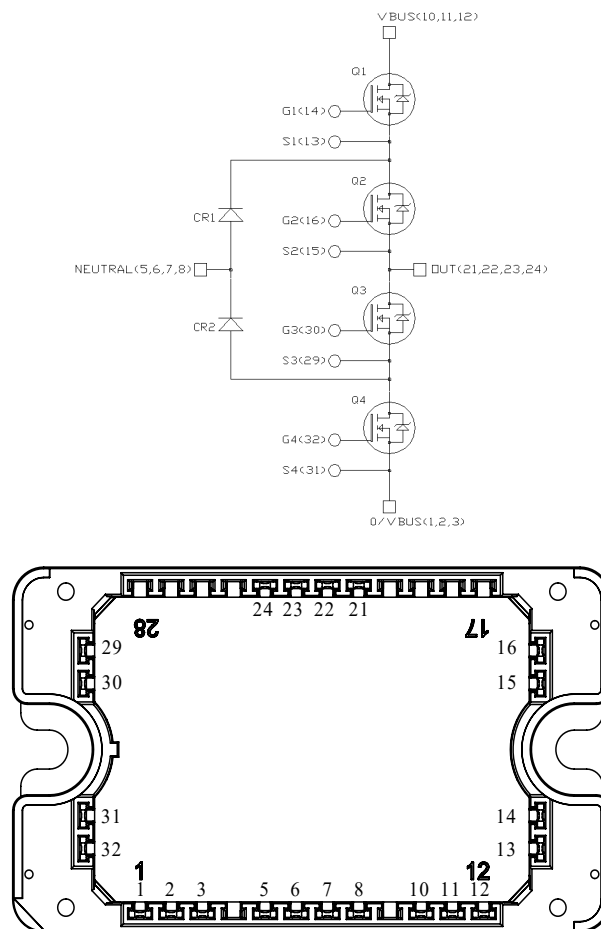


Three Level Inverter SiC MOSFET Power Module

Product Overview

The MSCSM120TLM16C3AG device is a 1200V/173A three level inverter silicon carbide (SiC) MOSFET power module.



Note:

1. All ratings at $T_J = 25^\circ\text{C}$, 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



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

Features

The following are the key features of MSCSM120TLM16C3AG 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 MSCSM120TLM16C3AG 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 MSCSM120TLM16C3AG device:

- Uninterruptible power supplies

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120TLM16C3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of MSCSM120TLM16C3AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	A
		$T_C = 80\text{ }^{\circ}\text{C}$	
I_{DM}	Pulsed drain current	350	
V_{GSmax}	Gate-Source voltage	-10/25	V
$R_{DS(on)}$	Drain-Source ON resistance	16	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	W

The following table lists the electrical characteristics of MSCSM120TLM16C3AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$	—	20	200	μA
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 80A$	$T_J = 25\text{ }^{\circ}\text{C}$	12.5	16	m Ω
			$T_J = 175\text{ }^{\circ}\text{C}$	20	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 2\text{ mA}$	1.8	2.8	—	V
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V$ $V_{DS} = 0V$	—	—	200	nA

The following table lists the dynamic characteristics of MSCSM120TLM16C3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C _{iss}	Input capacitance	V _{GS} = 0V	—	6040	—	pF
C _{oss}	Output capacitance	V _{DS} = 1000V	—	540	—	
C _{rss}	Reverse transfer capacitance	f = 1 MHz	—	50	—	
Q _g	Total gate charge	V _{GS} = -5V/20V	—	464	—	nC
Q _{gs}	Gate-Source charge	V _{Bus} = 800V	—	82	—	
Q _{gd}	Gate-Drain charge	I _D = 80A	—	100	—	
T _{d(on)}	Turn-on delay time	V _{GS} = -5V/20V	—	30	—	ns
T _r	Rise time	V _{Bus} = 600V	—	30	—	
T _{d(off)}	Turn-off delay time	I _D = 100A	—	50	—	
T _f	Fall time	R _{Gon} = 4Ω R _{Goff} = 2.4Ω	—	25	—	
E _{on}	Turn-on energy	V _{GS} = -5V/20V	T _J = 150 °C	1.98	—	mJ
E _{off}	Turn-off energy	V _{Bus} = 600V I _D = 100A R _{Gon} = 4Ω R _{Goff} = 2.4Ω		1.3	—	
R _{Gint}	Internal gate resistance		—	2.94	—	Ω
R _{thJC}	Junction-to-case thermal resistance		—	—	0.2	°C/W

The following table lists the body diode ratings and characteristics of MSCSM120TLM16C3AG 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} = 80A	—	4	—	V
		V _{GS} = -5V I _{SD} = 80A	—	4.2	—	
t _{rr}	Reverse recovery time	I _{SD} = 80A	—	90	—	ns
Q _{rr}	Reverse recovery charge	V _{GS} = -5V	—	1100	—	nC
I _{rr}	Reverse recovery current	V _R = 800V di _F /dt = 2000 A/μs	—	27	—	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 MSCSM120TLM16C3AG 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	$V_R = 1200\text{ V}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	30	μA
			$T_J = 175\text{ }^{\circ}\text{C}$	—	500	
I_F	DC forward current		$T_C = 100\text{ }^{\circ}\text{C}$	—	100	A
V_F	Diode forward voltage	$I_F = 100\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$	—	1.5	V
			$T_J = 175\text{ }^{\circ}\text{C}$	—	2.1	
Q_C	Total capacitive charge	$V_R = 600\text{ V}$	—	448	—	nC
C	Total capacitance	$f = 1\text{ MHz}$	—	492	—	pF
		$V_R = 400\text{ V}$				
		$f = 1\text{ MHz}$	—	363	—	
		$V_R = 800\text{ V}$				
R_{thJH}	Junction-to-heatsink thermal resistance		—	—	0.297	$^{\circ}\text{C/W}$

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120TLM16C3AG device.

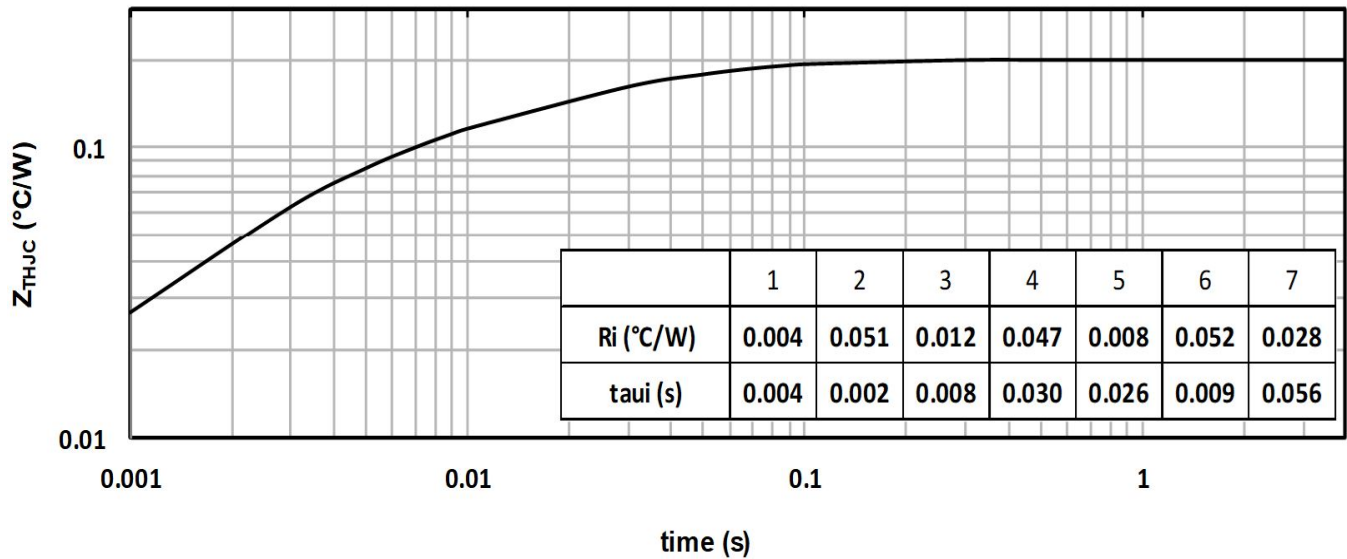
Table 1-6. Thermal and Package Characteristics

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 MSCSM120TLM16C3AG device.

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



MSCSM120TLM16C3AG

Electrical Specifications

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

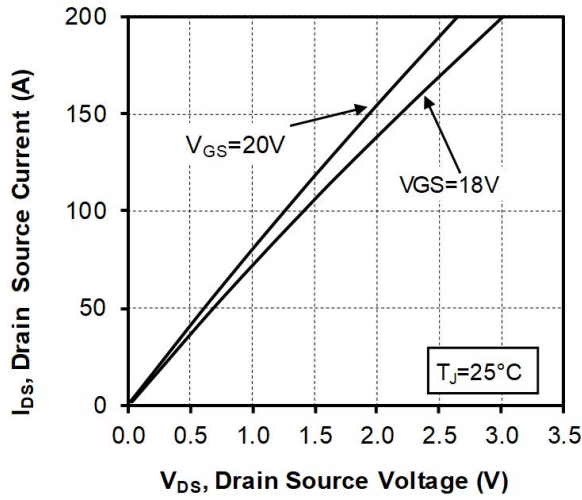


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

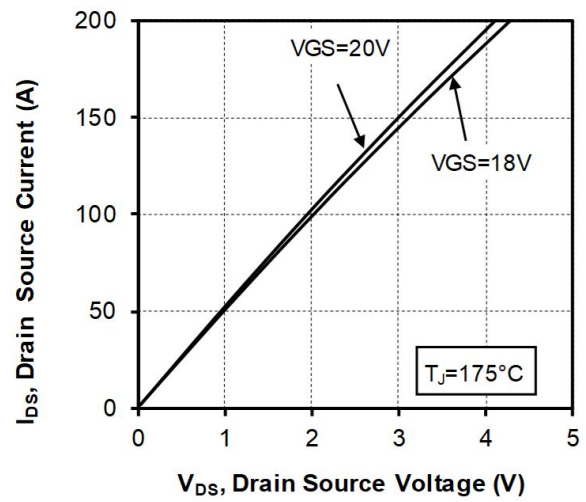


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

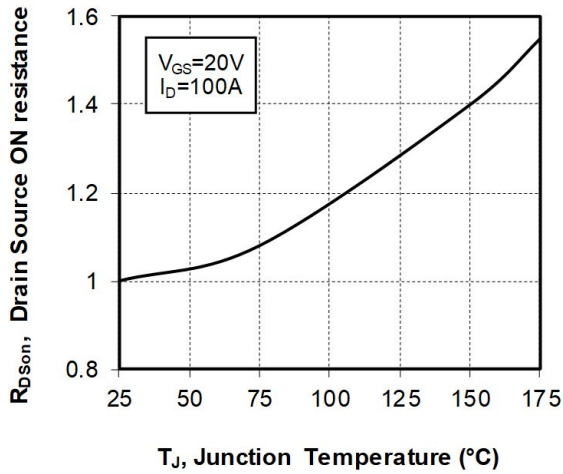


Figure 1-5. Transfer Characteristics

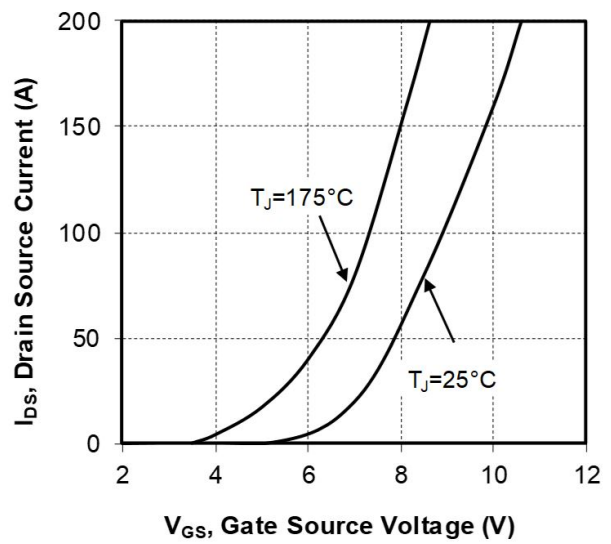


Figure 1-6. Switching Energy vs. R_g

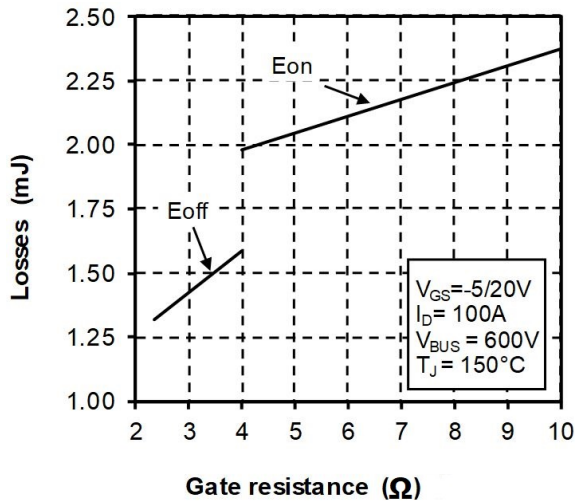


Figure 1-7. Switching Energy vs. Current

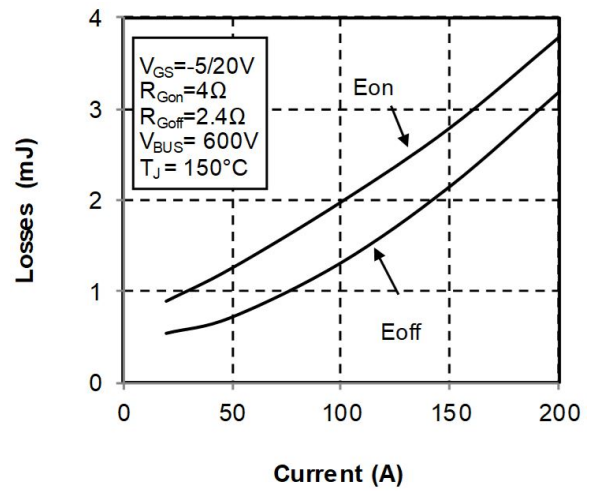


Figure 1-8. Capacitance vs. Drain Source Voltage

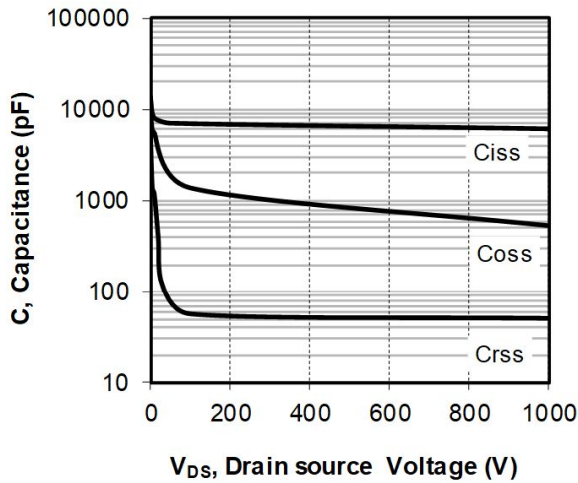


Figure 1-9. Gate Charge vs. Gate Source Voltage

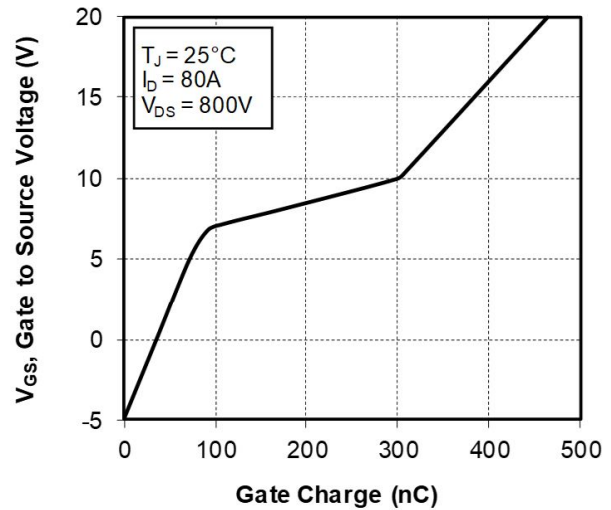


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

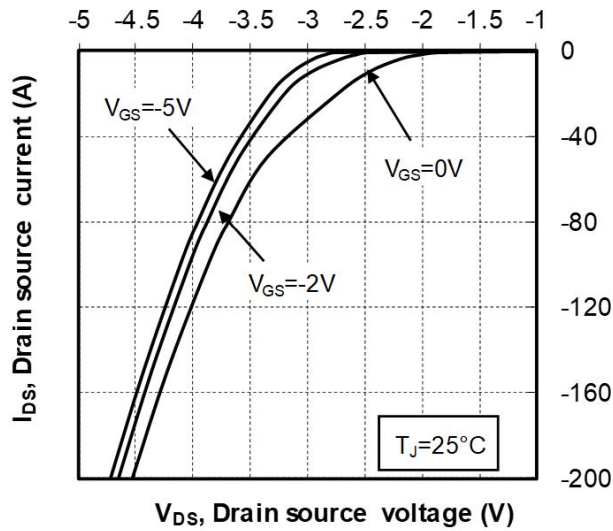


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

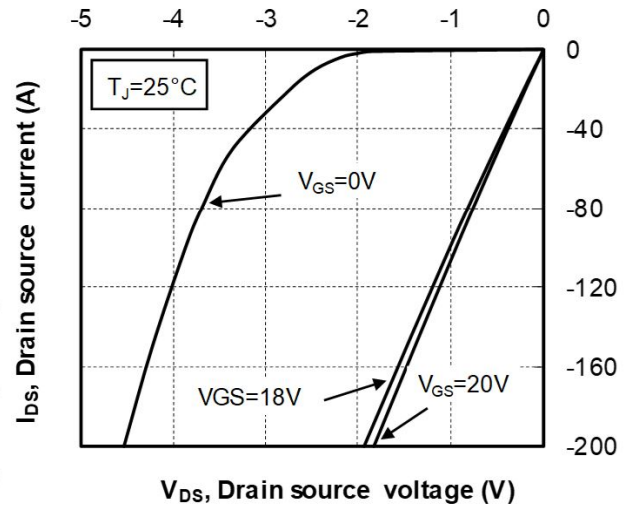


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

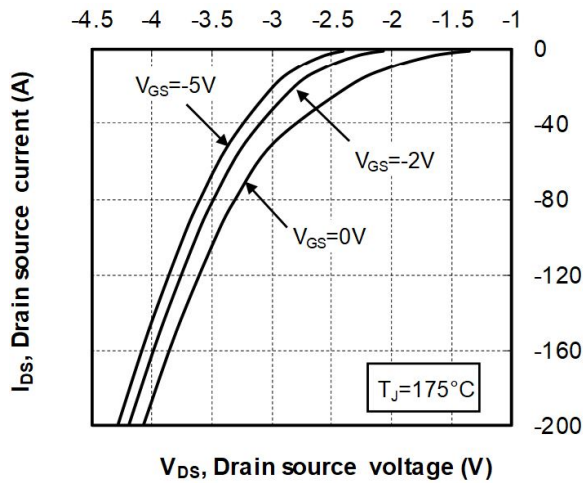


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

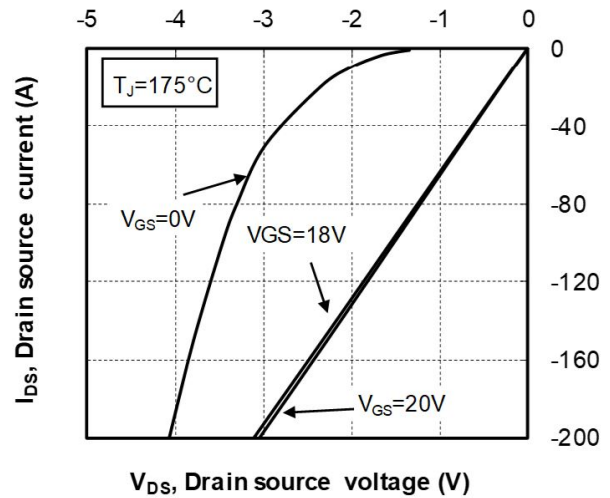
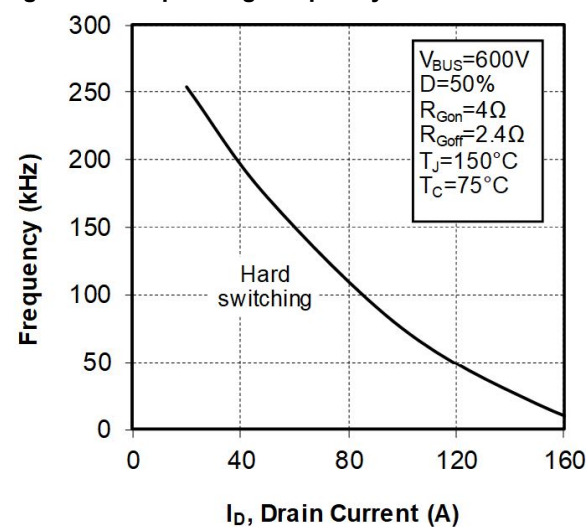


Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM120TLM16C3AG device.

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

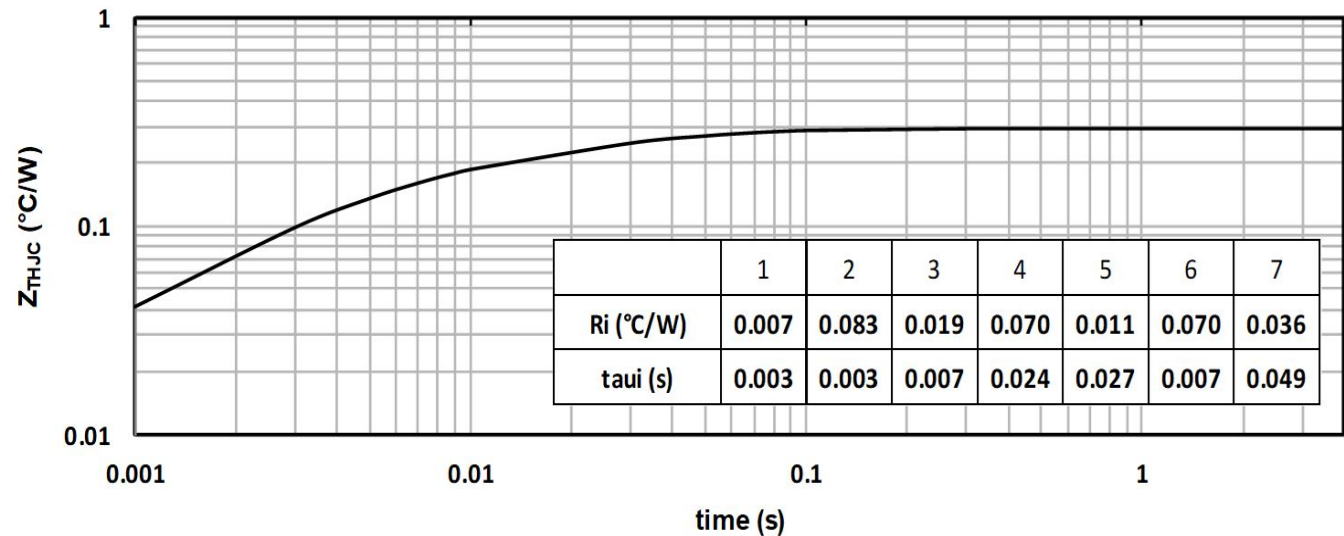


Figure 1-16. Forward Characteristics

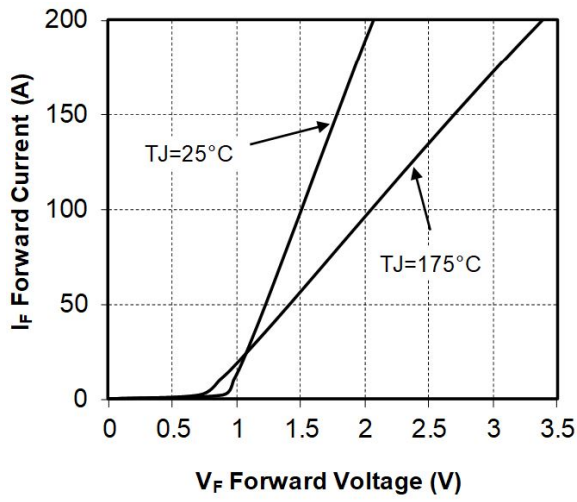
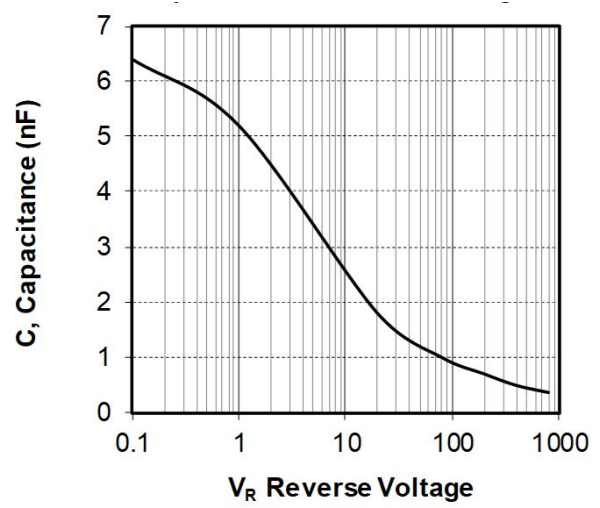


Figure 1-17. Capacitance vs. Reverse Voltage



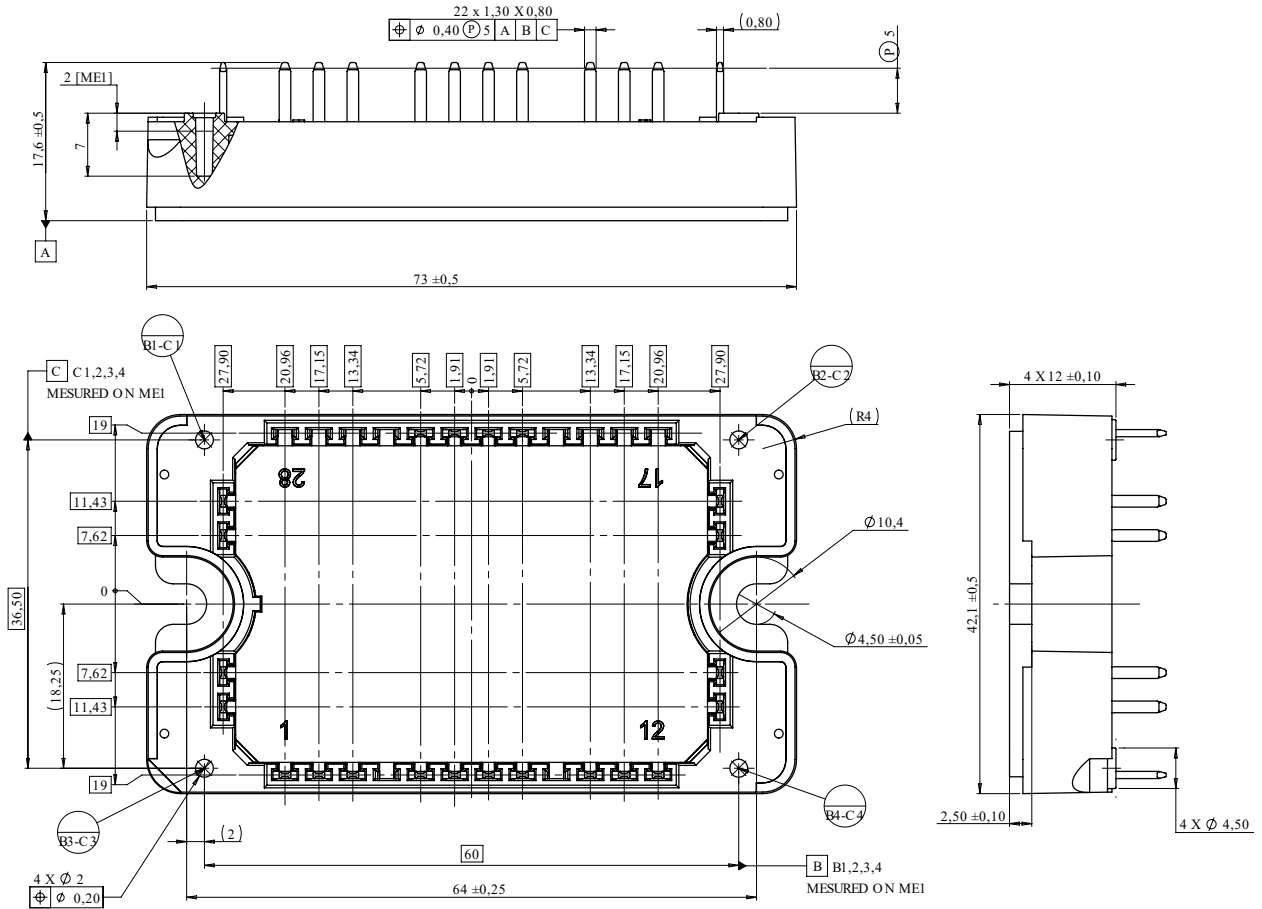
2. Package Specifications

The following section shows the package specification of the device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120TLM16C3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



3. Revision History

Revision	Date	Description
A	12/2021	Initial Revision

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