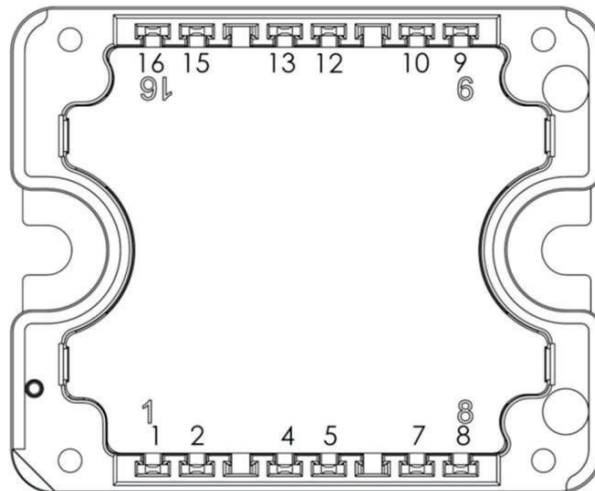
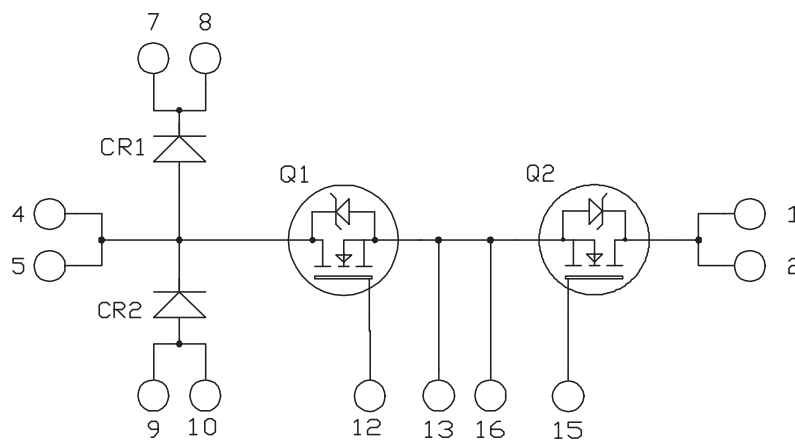


Vienna Rectifier SiC MOSFET Power Module

Product Overview

The MSCSM120VR1M31C1AG device is a Vienna rectifier 1200V, 89A silicon carbide (SiC) power module.



Notes:

- Pins 1/2; 4/5; 7/8; 9/10 must be shorted together.
- All ratings at $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified.



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

Features

The following are the key features of MSCSM120VR1M31C1AG device:

- SiC Power MOSFET
 - High speed switching
 - Low $R_{DS(on)}$
 - Ultra low loss
- SiC Schottky Diode
 - Zero reverse recovery
 - Zero forward recovery
 - Temperature independent switching behavior
 - Positive temperature coefficient on V_F
- Very low stray inductance
- Kelvin source for easy drive
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM120VR1M31C1AG device:

- Outstanding performance at high frequency operation
- High-power and high-efficiency rectifiers and converters
- 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

Applications

The following are the applications of MSCSM120VR1M31C1AG device:

- Power factor correction
- Switched mode power supplies
- Uninterruptible power supplies

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM120VR1M31C1AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM120VR1M31C1AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	89
		$T_C = 80\text{ }^\circ\text{C}$	71
I_{DM}	Pulsed drain current	180	
V_{GS}	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	31	$m\Omega$
P_D	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	395
			W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM120VR1M31C1AG 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	$V_{GS} = 20V$ $I_D = 40A$	$T_J = 25\text{ }^\circ\text{C}$	—	25	31	$m\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$; $I_D = 3\text{ mA}$	1.8	2.8	—	V	
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V$; $V_{DS} = 0V$	—	—	150	nA	

MSCSM120VR1M31C1AG

Electrical Specifications

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM120VR1M31C1AG device.

Table 1-3. Dynamic Characteristics

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

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM120VR1M31C1AG 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	$I_{SD} = 40A$	—	90	—	ns
Q_{rr}	Reverse recovery charge	$V_{GS} = -5V$	—	550	—	nC
I_{rr}	Reverse recovery current	$V_R = 800V$ $di_F/dt = 1000\text{ A}/\mu\text{s}$	—	13.5	—	A

1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of the MSCSM120VR1M31C1AG device.

Table 1-5. SiC Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
V_{RRM}	Peak repetitive reverse voltage		—	—	1700	V	
I_{RM}	Reverse leakage current	$V_R = 1700V$	$T_J = 25\text{ }^\circ\text{C}$	—	50	200	μA
			$T_J = 175\text{ }^\circ\text{C}$	—	250	—	
I_F	DC Forward current			50	—	A	
V_F	Diode forward voltage	$I_F = 50A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2	—	
Q_C	Total capacitive charge	$V_R = 900V$	—	410	—	nC	
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600V$	—	300	—	pF	
		$f = 1\text{ MHz}, V_R = 900V$	—	250	—		
R_{thJC}	Junction-to-case thermal resistance		—	—	0.32	$^\circ\text{C/W}$	

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120VR1M31C1AG device.

Table 1-6. Thermal and Package Characteristics

Symbol	Characteristic	Min.	Max.	Unit		
V_{ISOL}	RMS isolation voltage, any terminal to case $t = 1\text{ min}$, 50 Hz/60 Hz	4000	—	V		
T_J	Operating junction temperature range	−40	175	$^\circ\text{C}$		
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
Wt	Package weight	—	80	g		

1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM120VR1M31C1AG device.

Figure 1-1. Maximum Thermal Impedance

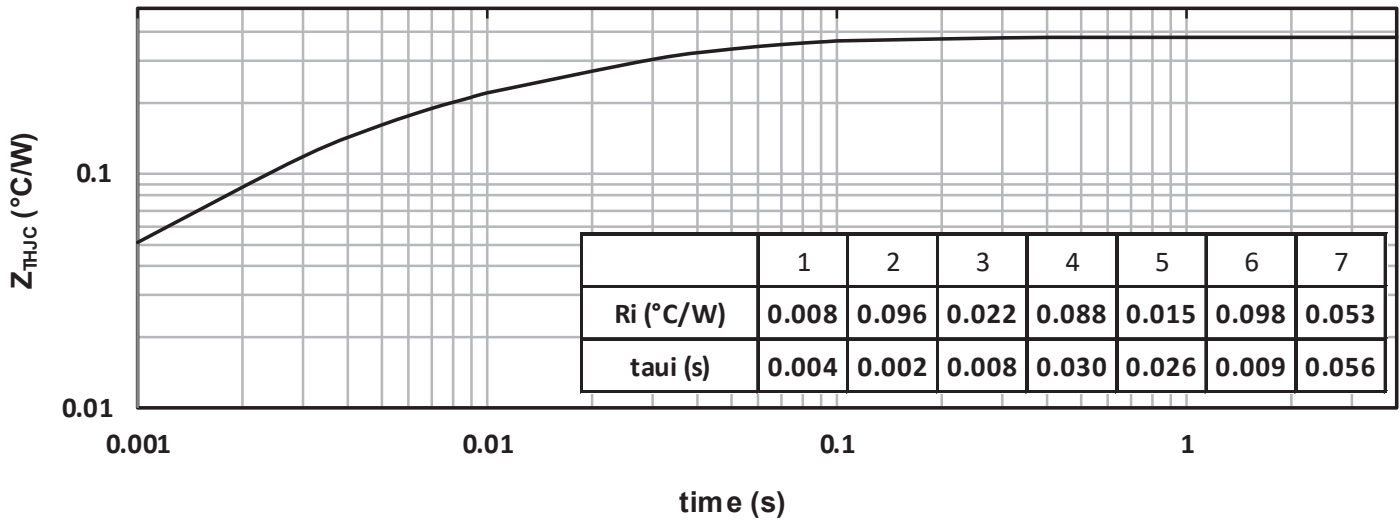


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

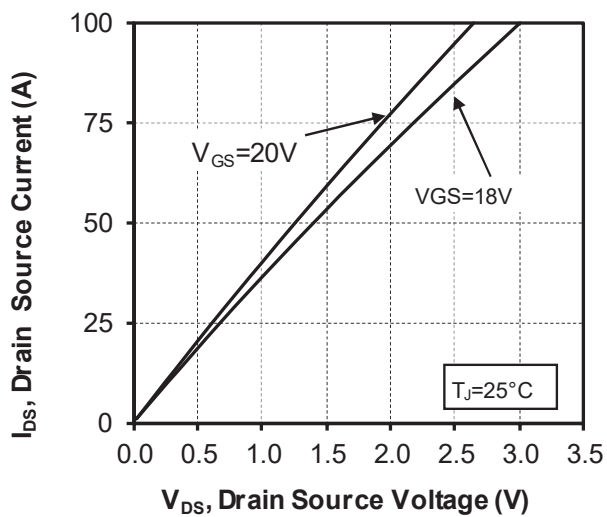
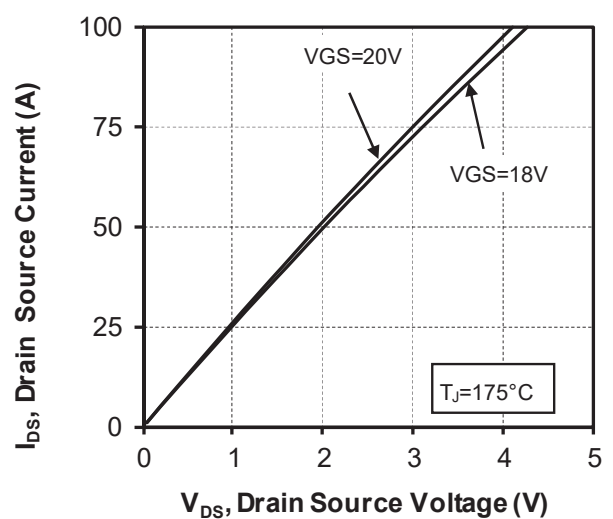


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$



MSCSM120VR1M31C1AG

Electrical Specifications

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

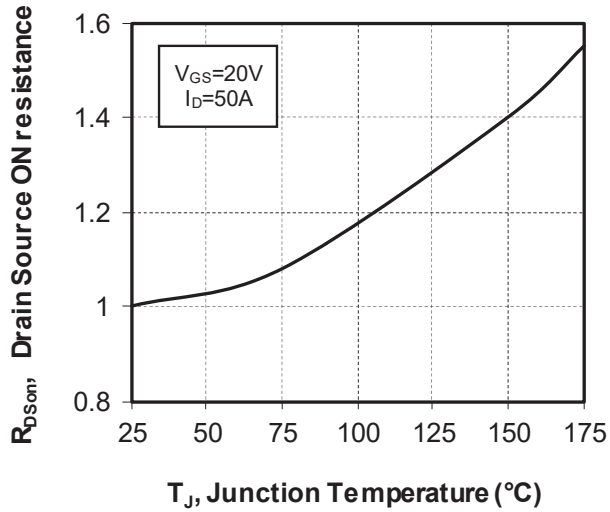


Figure 1-5. Transfer Characteristics

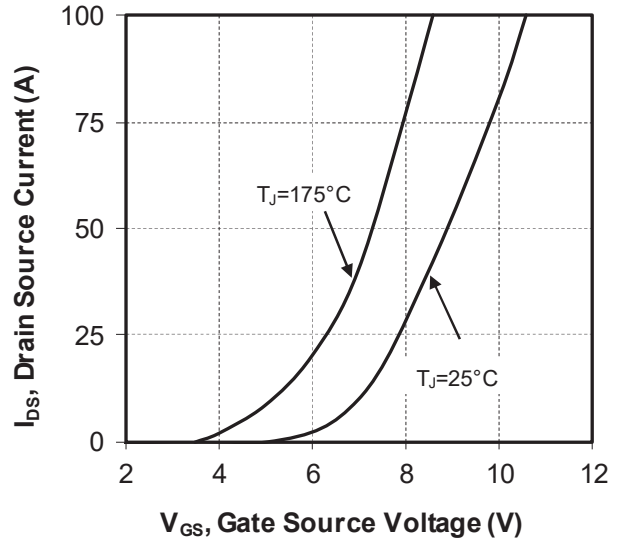


Figure 1-6. Switching Energy vs. Rg

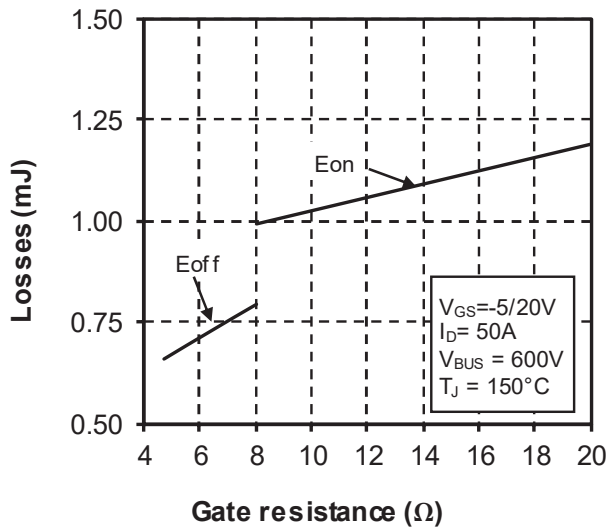
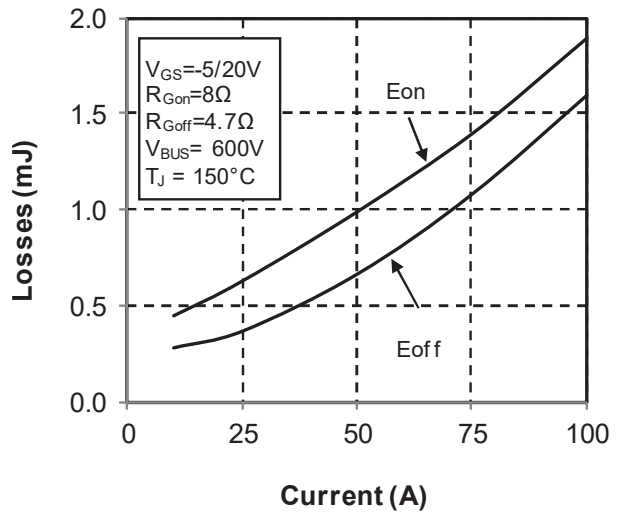


Figure 1-7. Switching Energy vs. Current



MSCSM120VR1M31C1AG

Electrical Specifications

Figure 1-8. Capacitance vs. Drain Source Voltage

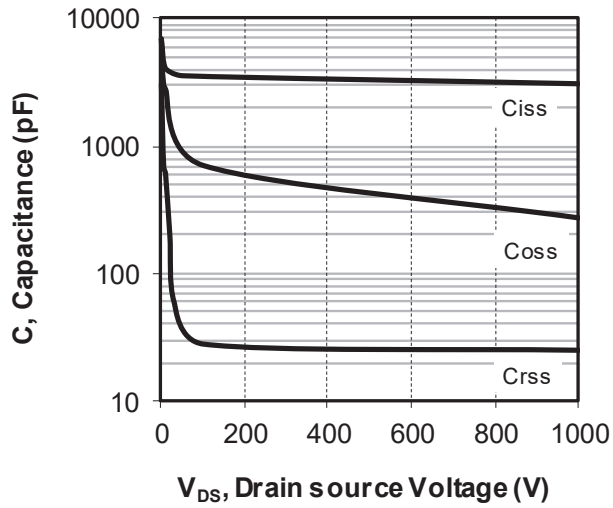


Figure 1-9. Gate Charge vs. Gate Source Voltage

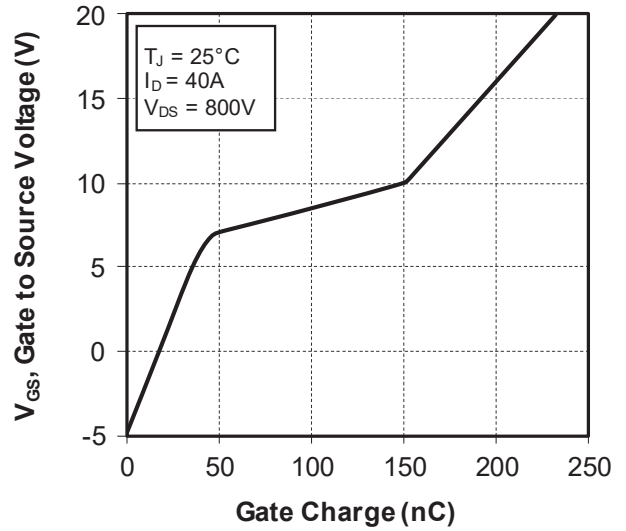


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

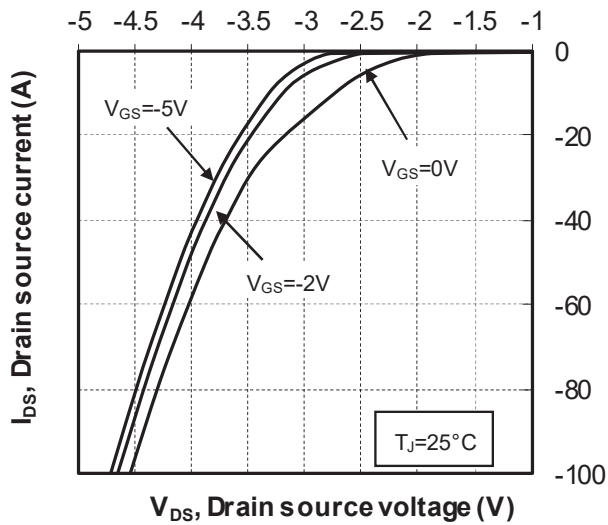
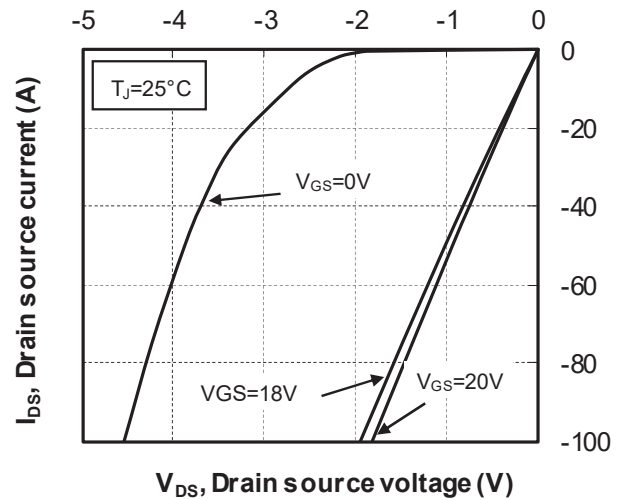


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$



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Electrical Specifications

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

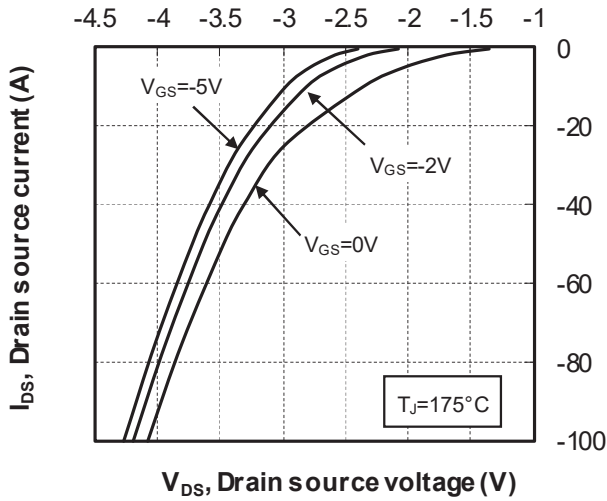


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

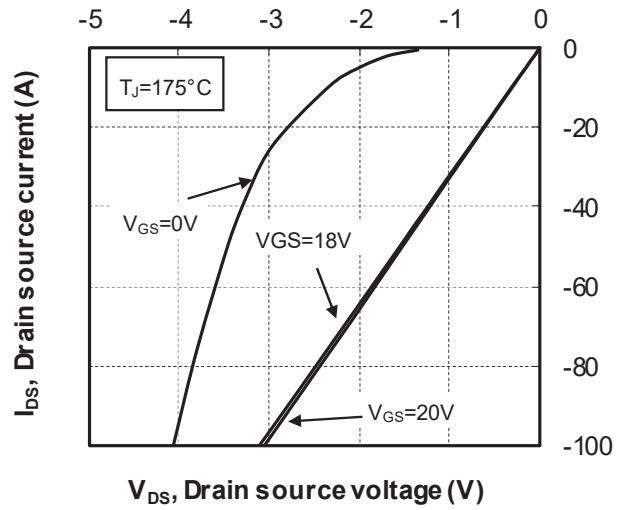
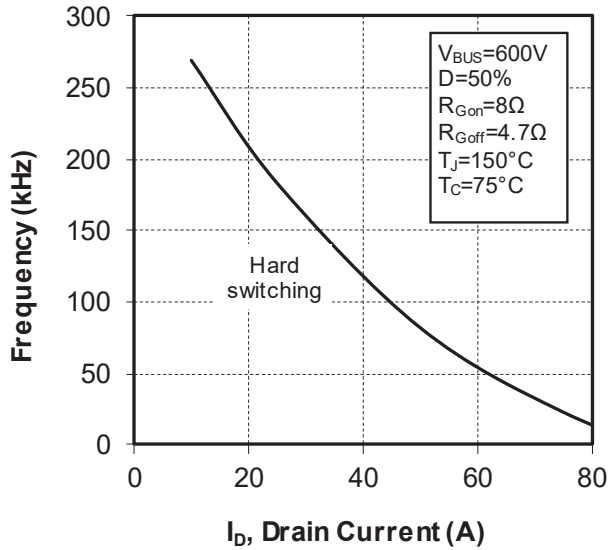


Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM120VR1M31C1AG device.

Figure 1-15. Maximum Thermal Impedance

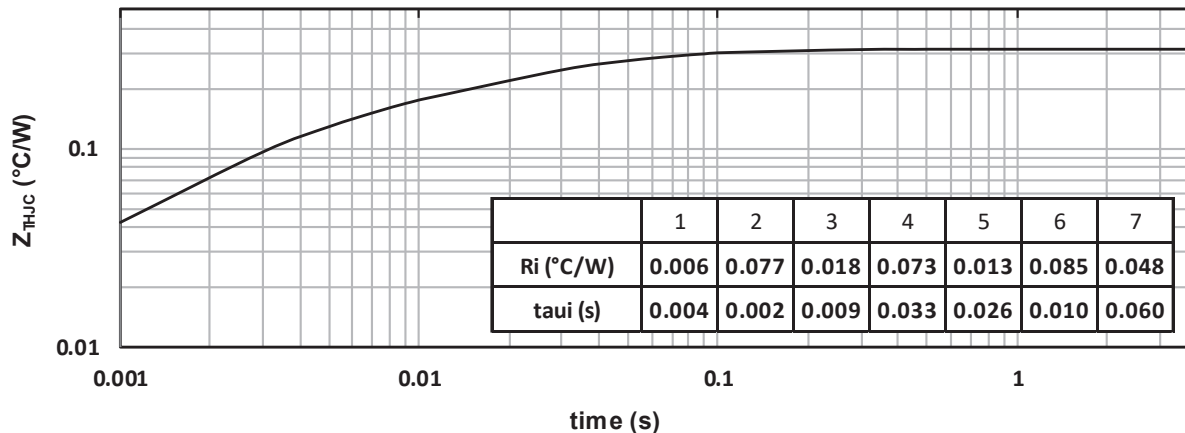


Figure 1-16. Forward Characteristics

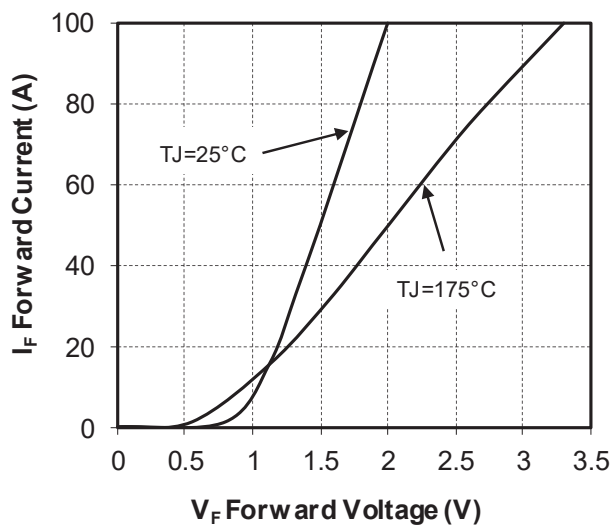
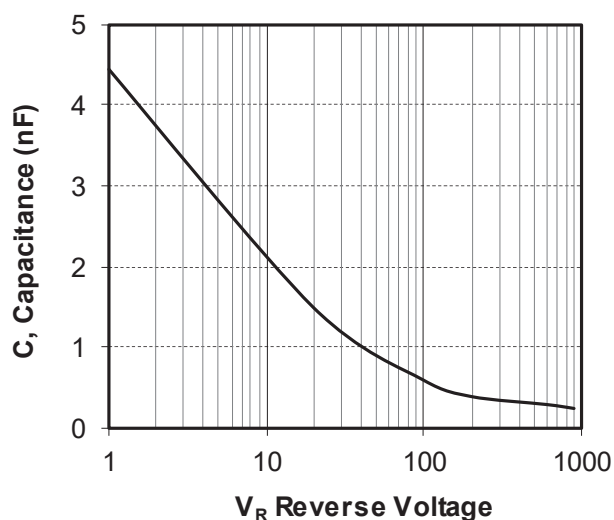


Figure 1-17. Capacitance vs. Reverse Voltage



MSCSM120VR1M31C1AG

Package Specifications

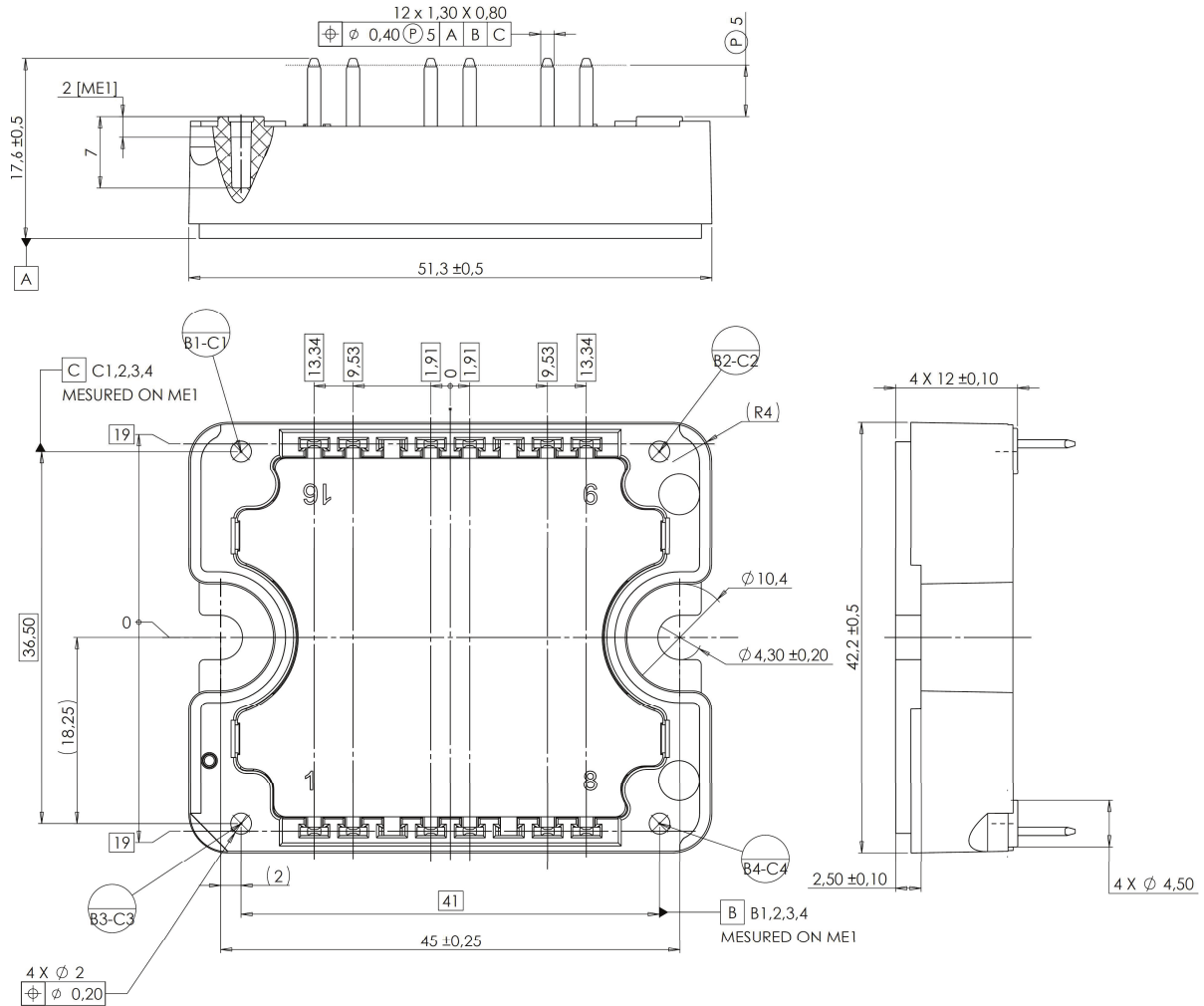
2. Package Specifications

The following section shows the package specification of the MSCSM120VR1M31C1AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120VR1M31C1AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See [AN3500A—Mounting Instructions for SP1F and SP3F Power Modules](#) for more information.

3. Revision History

Revision	Date	Description
A	08/2022	Initial Revision

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