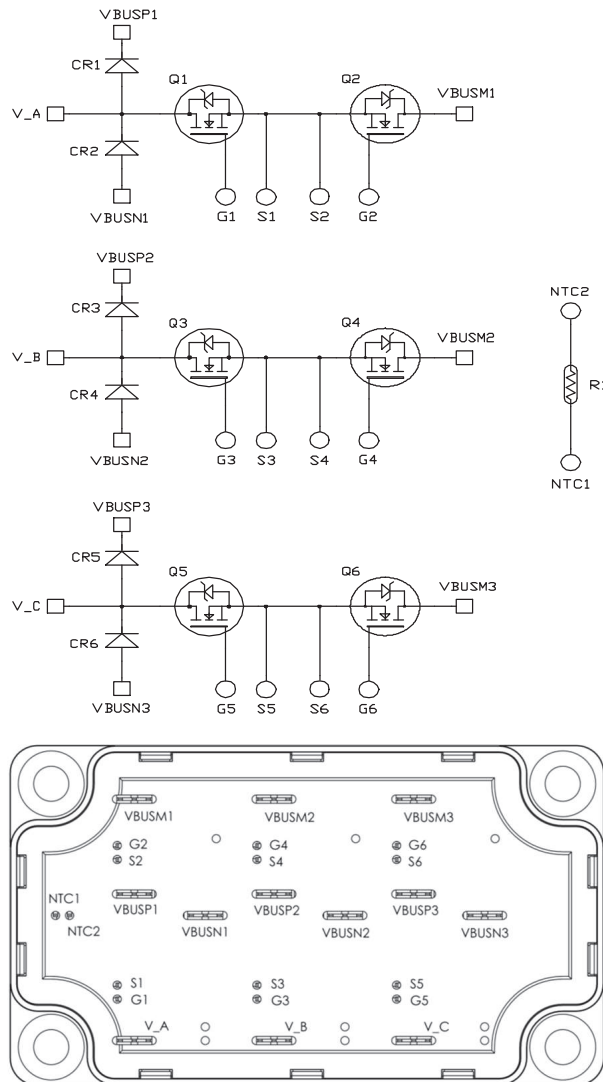


Triple Vienna Rectifier SiC MOSFET Power Module

Product Overview

The MSCSM120VR1M16CTPAG device is a triple Vienna rectifier 1200V, 171A silicon carbide (SiC) power module.



Note: 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 MSCSM120VR1M16CTPAG device:

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

Benefits

The following are the benefits of MSCSM120VR1M16CTPAG 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 MSCSM120VR1M16CTPAG device:

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

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM120VR1M16CTPAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM120VR1M16CTPAG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	171
		$T_C = 80\text{ }^\circ\text{C}$	136 ¹
I_{DM}	Pulsed drain current	350	
V_{GS}	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	16	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	728

Note:

1. Specification of SiC MOSFET device but output current must be limited due to size of power connectors.

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM120VR1M16CTPAG 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	$V_{GS} = V_{DS}$; $I_D = 6\text{ mA}$	1.8	2.8	—	V	
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V$; $V_{DS} = 0V$	—	—	200	nA	

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The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM120VR1M16CTPAG 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	$f = 1\text{ MHz}$	—	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	$R_{GON} = 4\Omega$ $R_{GOFF} = 2.4\Omega$	—	25	—	
E_{on}	Turn-on energy	$V_{GS} = -5V/20V$	—	1.98	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 600V$ $I_D = 100A$ $R_{GON} = 4\Omega$ $R_{GOFF} = 2.4\Omega$				
R_{Gint}	Internal gate resistance		—	2.94	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.206	$^\circ\text{C/W}$

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM120VR1M16CTPAG 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	$V_R = 800V$ $di_F/dt = 2000\text{ A}/\mu\text{s}$	—	27	—	A

1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of the MSCSM120VR1M16CTPAG 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	$V_R = 1700V$	$T_J = 25\text{ }^\circ\text{C}$	—	20	400	μA
			$T_J = 175\text{ }^\circ\text{C}$	—	300	—	
I_F	DC Forward current	$T_C = 125\text{ }^\circ\text{C}$		—	60	—	A
V_F	Diode forward voltage	$I_F = 60A$	$T_J = 25\text{ }^\circ\text{C}$	—	1.5	1.8	V
			$T_J = 175\text{ }^\circ\text{C}$	—	2.3	—	
Q_C	Total capacitive charge	$V_R = 900V$		—	460	—	nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 600V$		—	334	—	pF
		$f = 1\text{ MHz}, V_R = 900V$		—	276	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.282	$^\circ\text{C/W}$

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120VR1M16CTPAG 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	M6	3	5	N.m
Wt	Package weight	—	250			g

The following table lists the temperature sensor NTC of the MSCSM120VR1M16CTPAG 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 = 298.15K	—	3952	—	K
ΔB/B	—	T _C = 100 °C	4	—	%

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

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

The following figures show the SiC MOSFET performance curves of the MSCSM120VR1M16CTPAG device.

Figure 1-1. Maximum Thermal Impedance

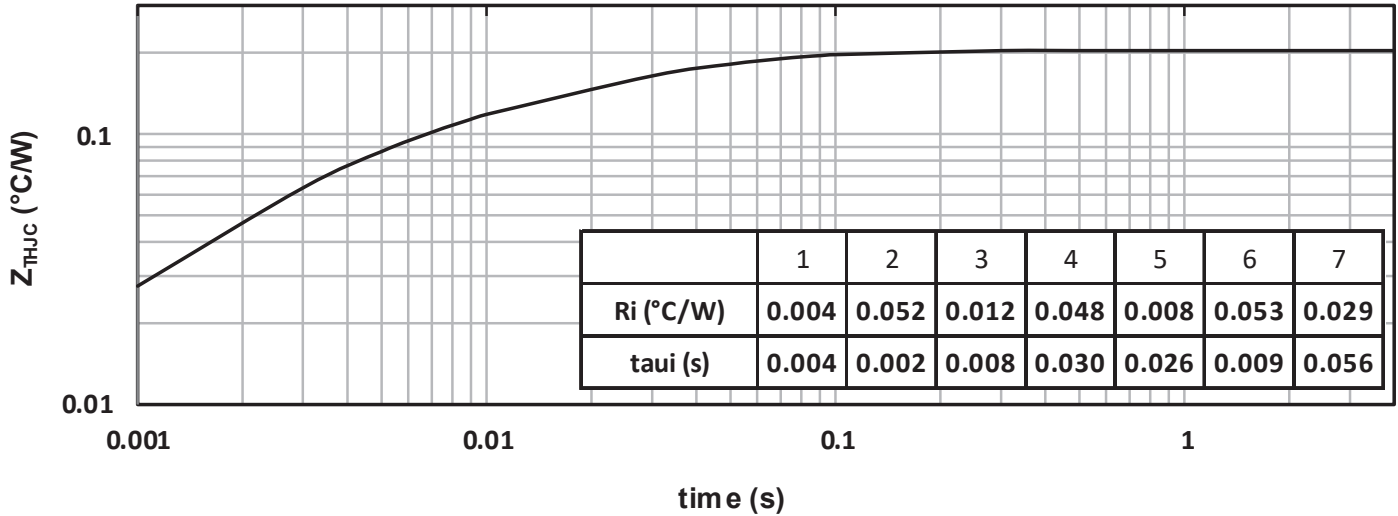


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

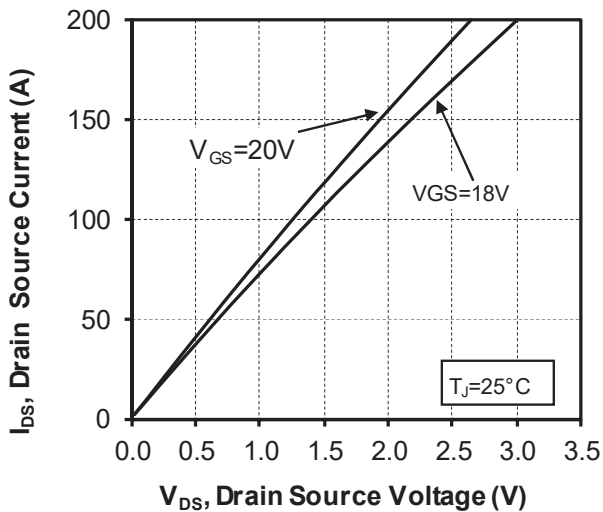
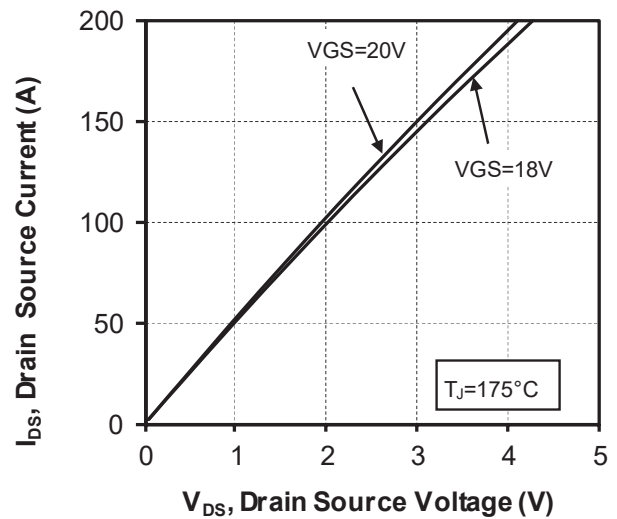


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$



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Electrical Specifications

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

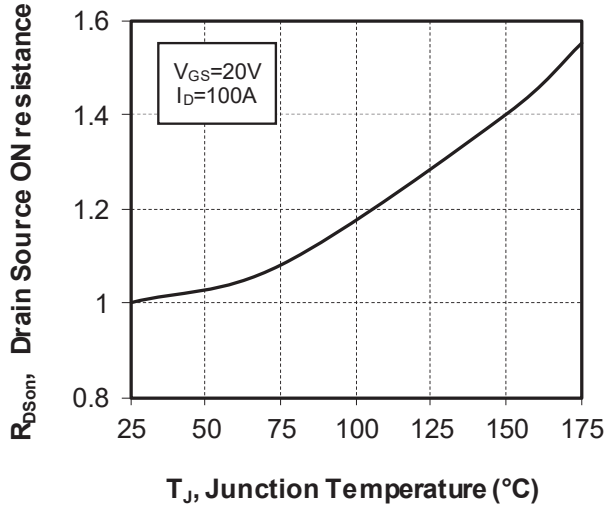


Figure 1-5. Transfer Characteristics

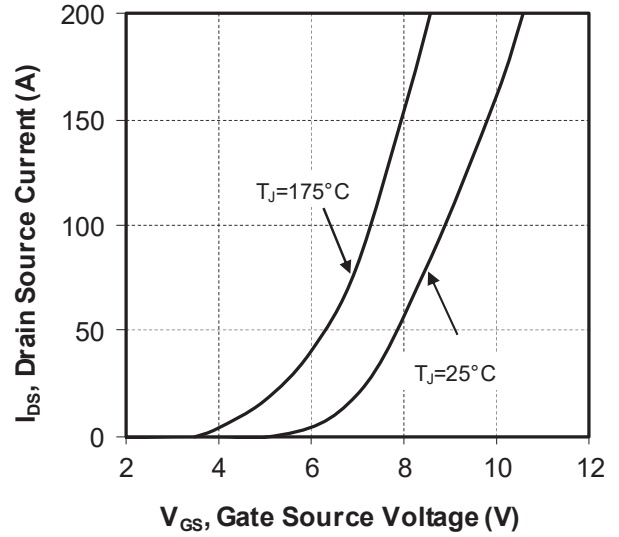


Figure 1-6. Switching Energy vs. R_g

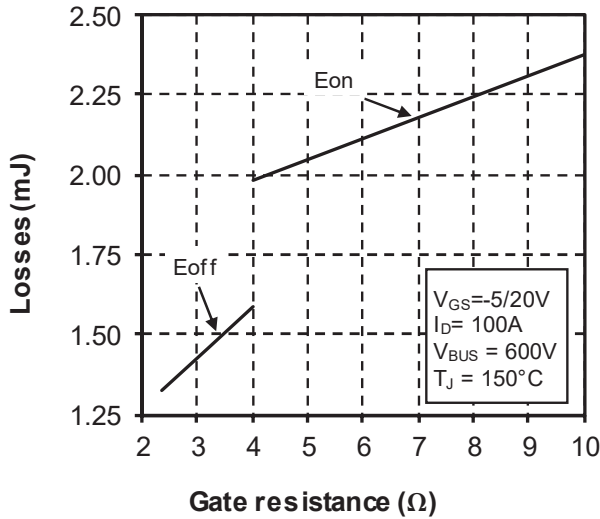
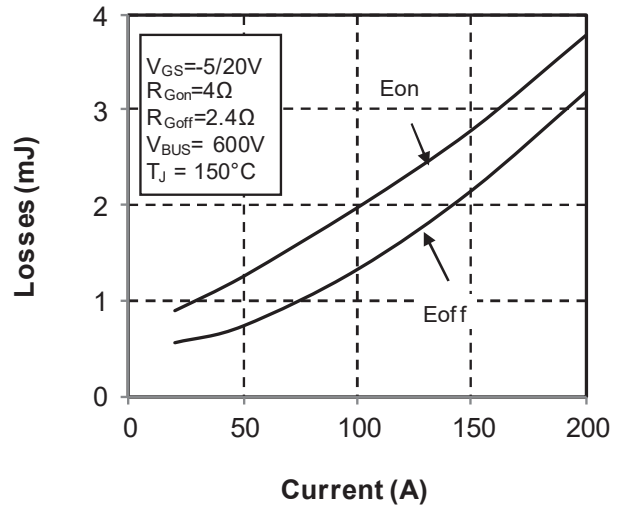


Figure 1-7. Switching Energy vs. Current



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Electrical Specifications

Figure 1-8. Capacitance vs. Drain Source Voltage

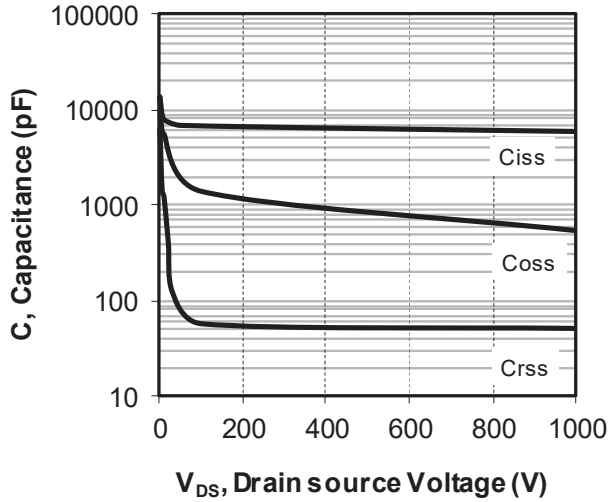


Figure 1-9. Gate Charge vs. Gate Source Voltage

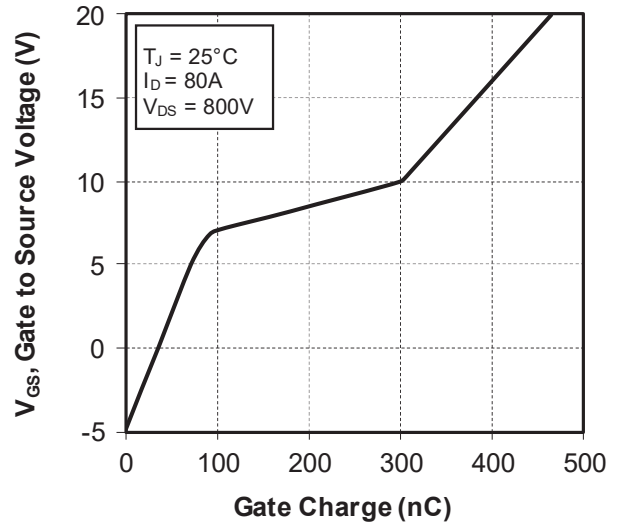


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

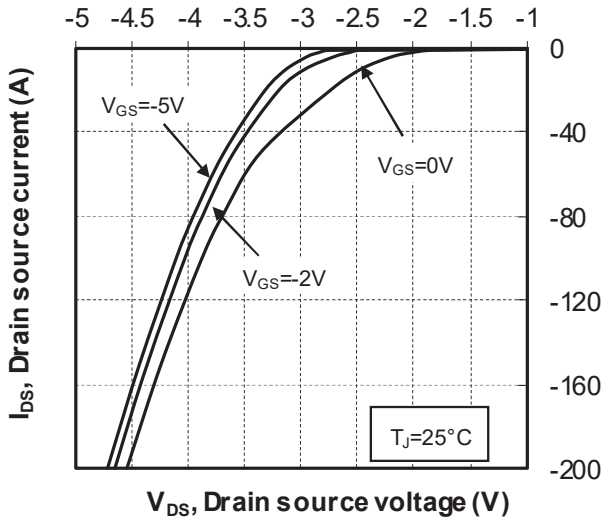
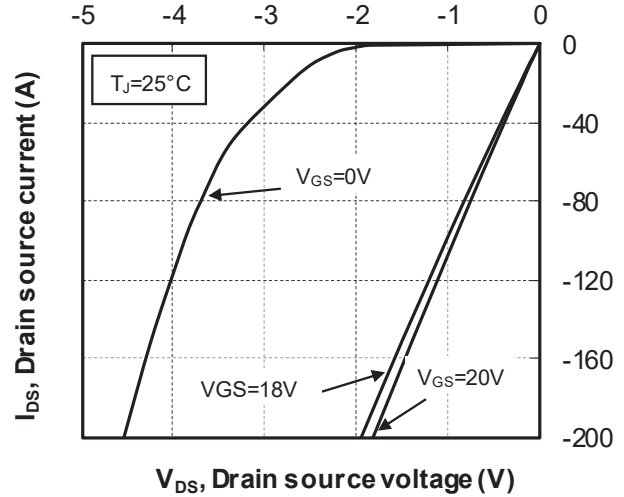


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$



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

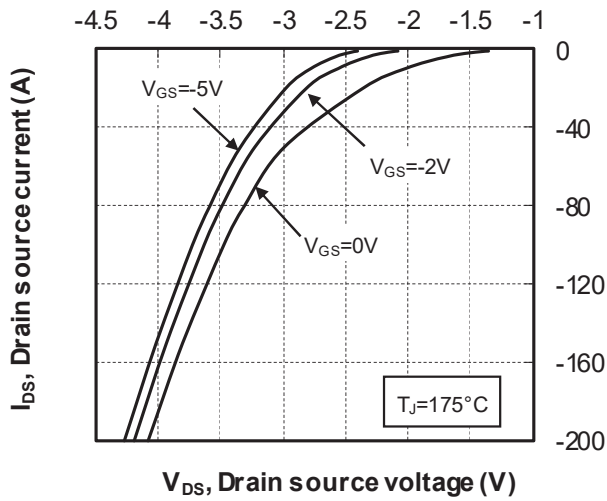


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

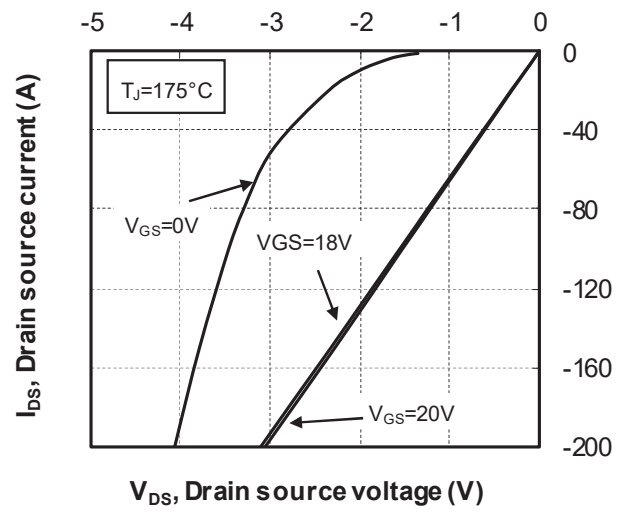
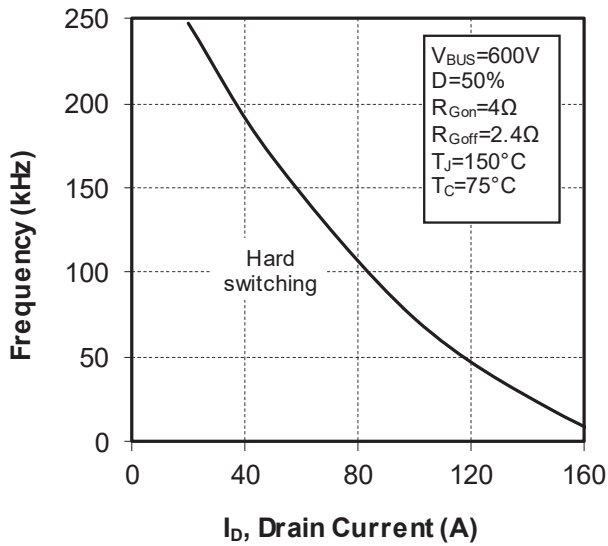


Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM120VR1M16CTPAG device.

Figure 1-15. Maximum Thermal Impedance

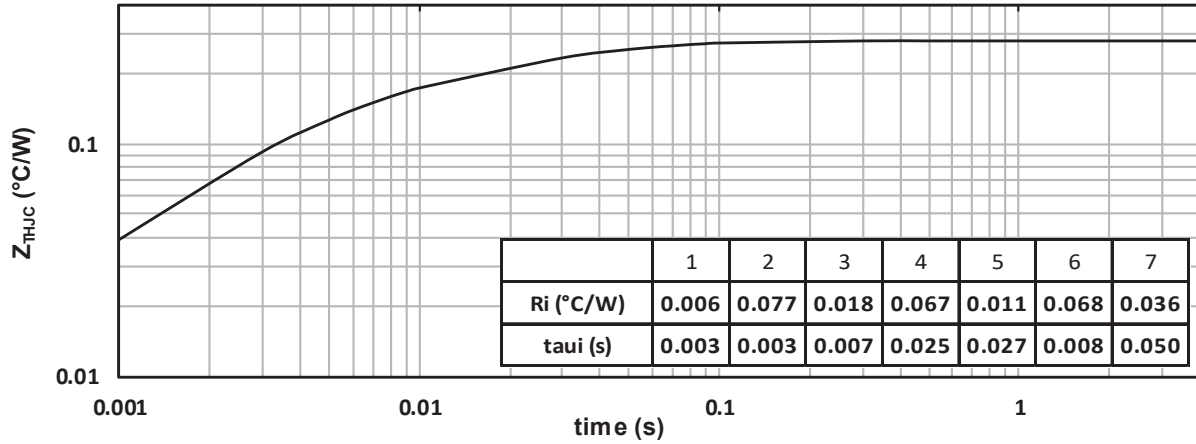


Figure 1-16. Forward Characteristics

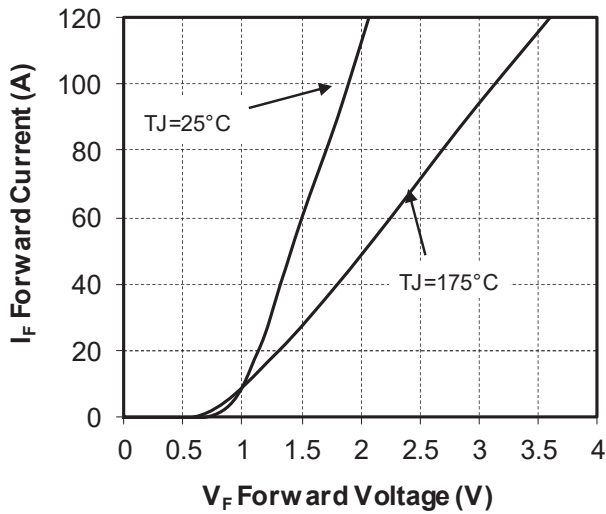
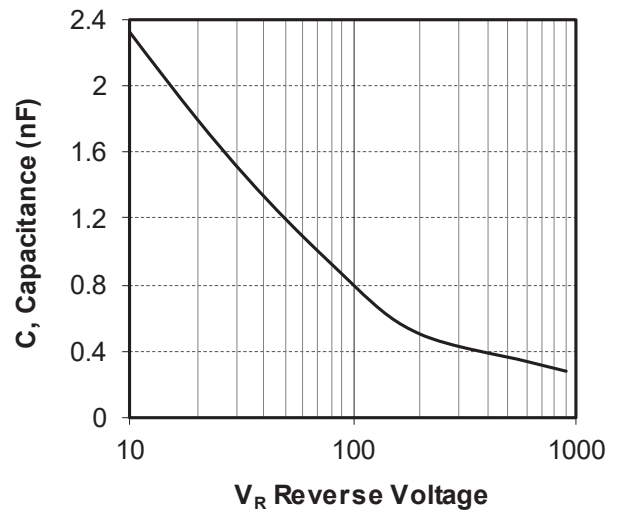


Figure 1-17. Capacitance vs. Reverse Voltage



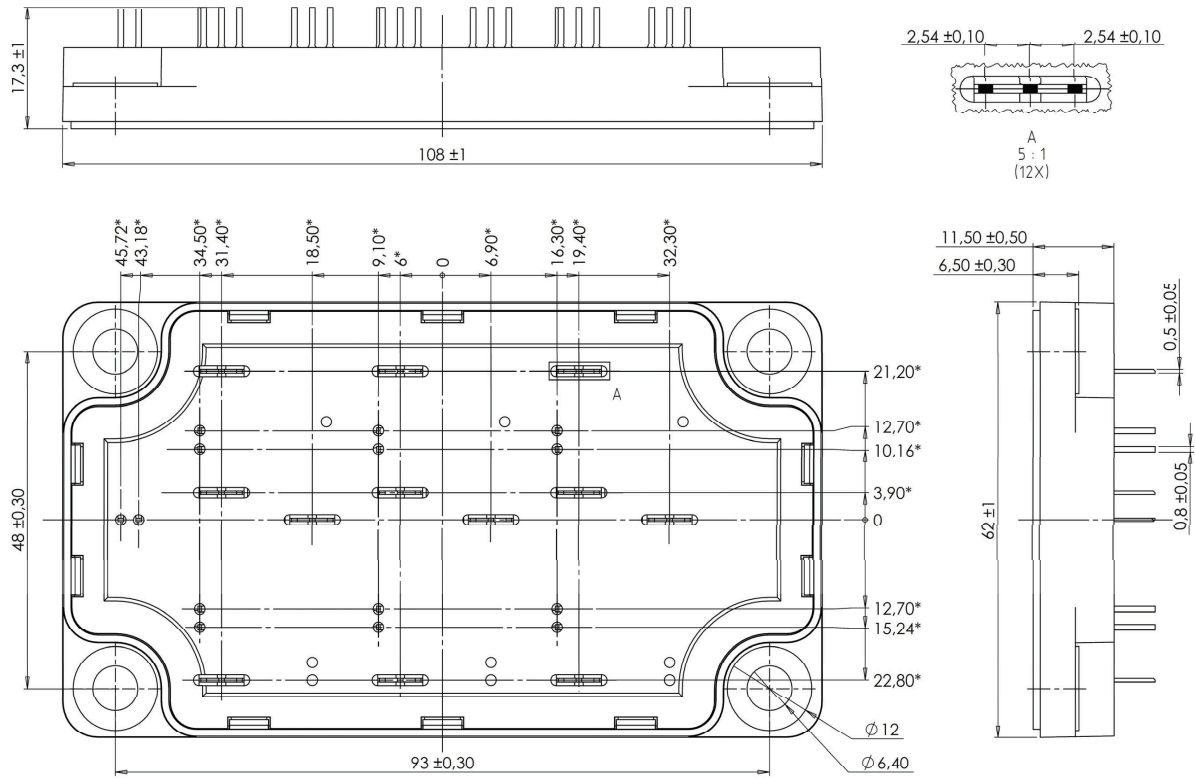
2. Package Specifications

The following section shows the package specification of the MSCSM120VR1M16CTPAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120VR1M16CTPAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



ALL DIMENSIONS MARKED "*" ARE TOLERANCED AS: ± 0.1

Note: See [AN1902—Mounting Instructions for SP6-P \(12 mm\) Power Modules](#) for more Information.

3. Revision History

Revision	Date	Description
A	08/2022	Initial Revision

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