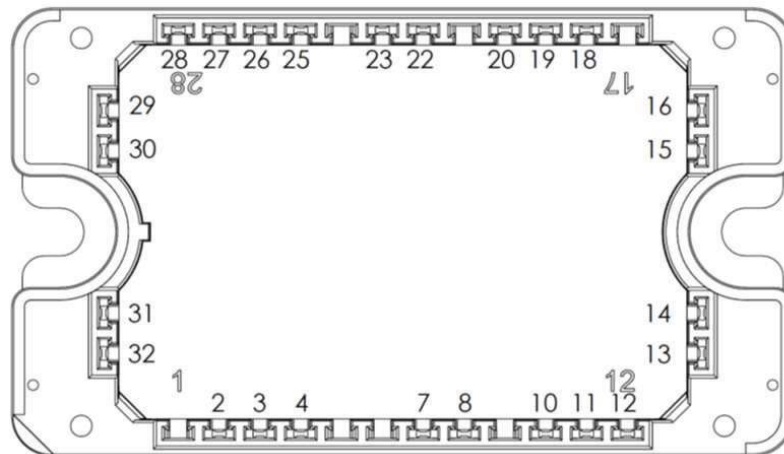
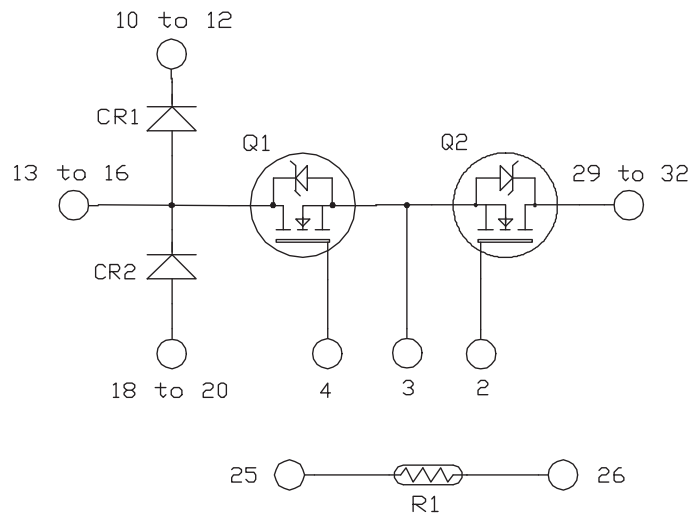


## Vienna Rectifier SiC MOSFET Power Module

### Product Overview

The MSCSM120VR1M16CT3AG device is a Vienna rectifier 1200V, 173A silicon carbide (SiC) power module.



**Notes:**

- All multiple inputs and outputs must be shorted together: 10 to 12; 13 to 16; 18 to 20; 29 to 32.
- 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 MSCSM120VR1M16CT3AG 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 MSCSM120VR1M16CT3AG device:

- High-power and high-efficiency rectifiers and converters
- 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

## Applications

The following are the applications of MSCSM120VR1M16CT3AG device:

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

# MSCSM120VR1M16CT3AG

## Electrical Specifications

## 1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM120VR1M16CT3AG device.

### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM120VR1M16CT3AG device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	173 <sup>1</sup>
		$T_C = 80\text{ }^\circ\text{C}$	138 <sup>1</sup>
$I_{DM}$	Pulsed drain current	350	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	16	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	745

**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 MSCSM120VR1M16CT3AG 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	$\mu\text{A}$	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 80A$	$T_J = 25\text{ }^\circ\text{C}$	—	12.5	16	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	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	

# MSCSM120VR1M16CT3AG

## Electrical Specifications

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM120VR1M16CT3AG 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	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.2	$^\circ\text{C/W}$

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM120VR1M16CT3AG 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 MSCSM120VR1M16CT3AG 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	$\mu\text{A}$	
			$T_J = 175\text{ }^\circ\text{C}$	—	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		—	—	0.276	$^\circ\text{C/W}$		

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120VR1M16CT3AG device.

**Table 1-6. Thermal and Package Characteristics**

Symbol	Characteristic	Min.	Max.	Unit		
V <sub>ISOL</sub>	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz	4000	—	V		
T <sub>J</sub>	Operating junction temperature range	−40	175	°C		
T <sub>JOP</sub>	Recommended junction temperature under switching conditions	−40	T <sub>Jmax</sub> −25			
T <sub>STG</sub>	Storage case temperature	−40	125			
T <sub>C</sub>	Operating case temperature	−40	125			
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package weight	—	110			g

The following table lists the temperature sensor NTC of the MSCSM120VR1M16CT3AG device.

**Table 1-7. Temperature Sensor NTC**

Symbol	Characteristic	Min.	Typ.	Max.	Unit
R <sub>25</sub>	Resistance at 25 °C	—	50	—	kΩ
ΔR <sub>25</sub> /R <sub>25</sub>	—	—	5	—	%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15K	—	3952	—	K
ΔB/B	—	T <sub>C</sub> = 100 °C	4	—	%

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

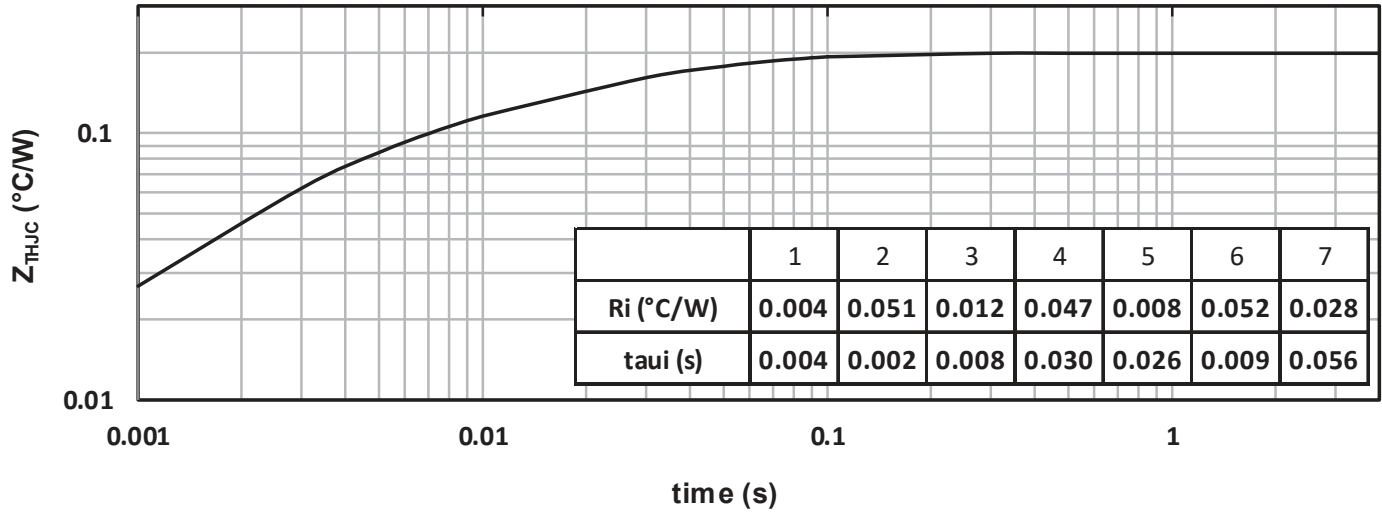
T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

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

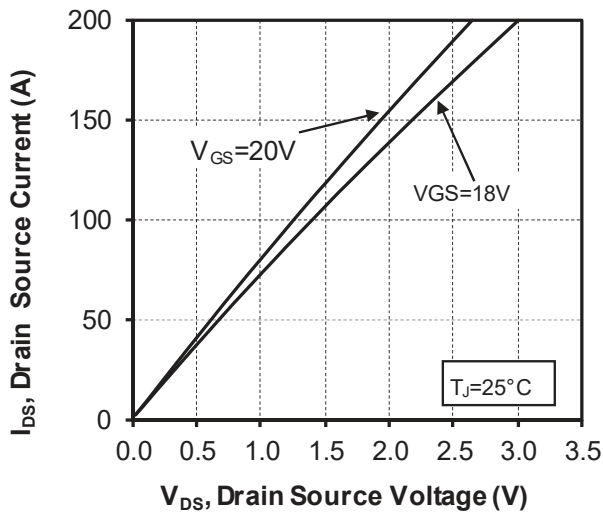
### 1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM120VR1M16CT3AG device.

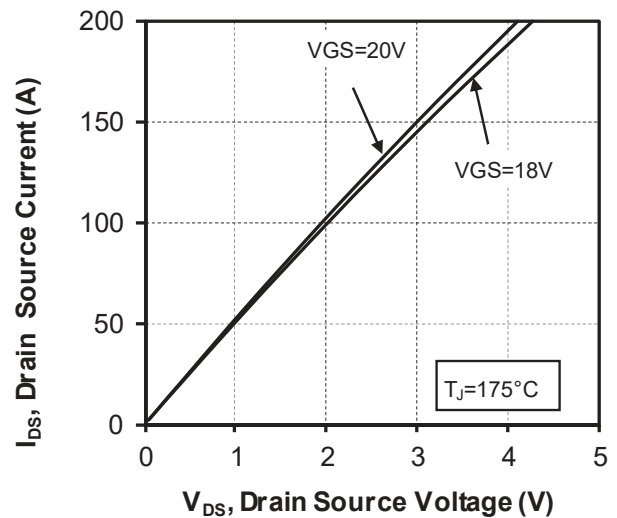
**Figure 1-1. Maximum Thermal Impedance**



**Figure 1-2. Output Characteristics, T<sub>J</sub> = 25 °C**



**Figure 1-3. Output Characteristics, T<sub>J</sub> = 175 °C**



# MSCSM120VR1M16CT3AG

## Electrical Specifications

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

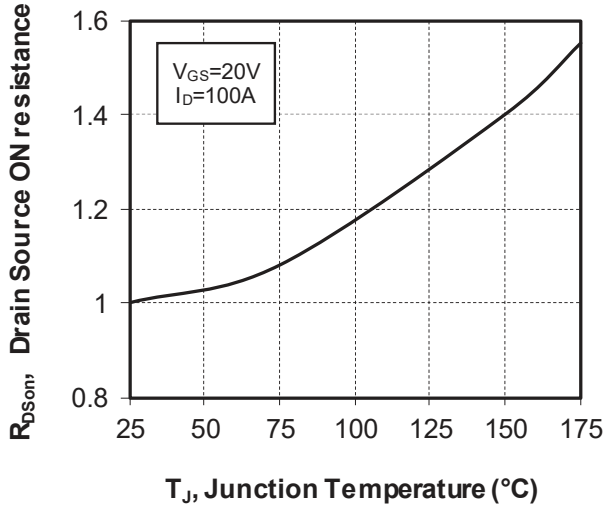


Figure 1-5. Transfer Characteristics

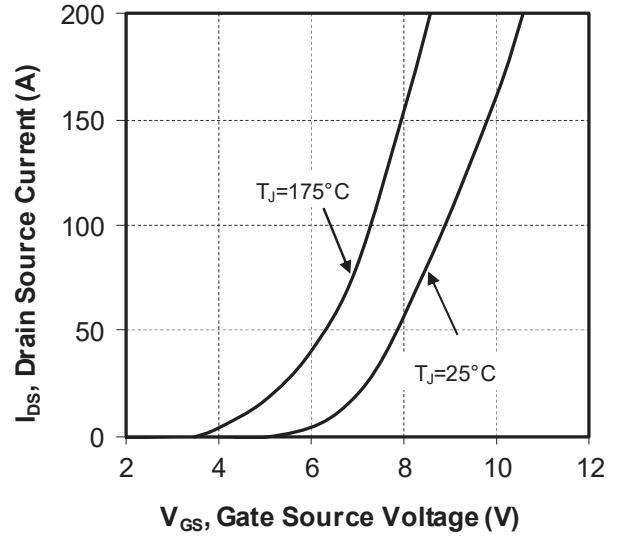


Figure 1-6. Switching Energy vs.  $R_g$

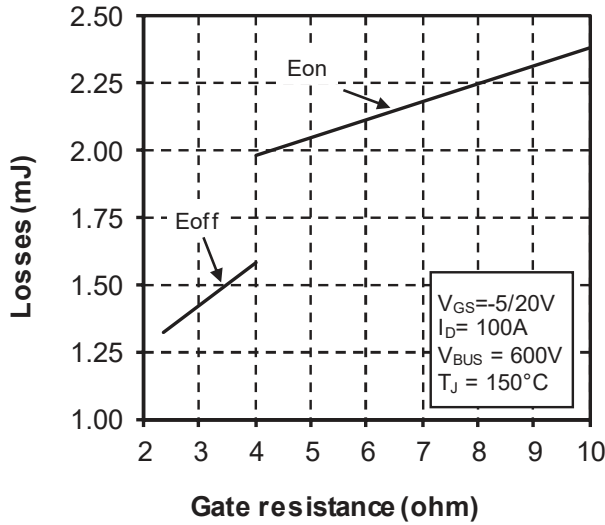
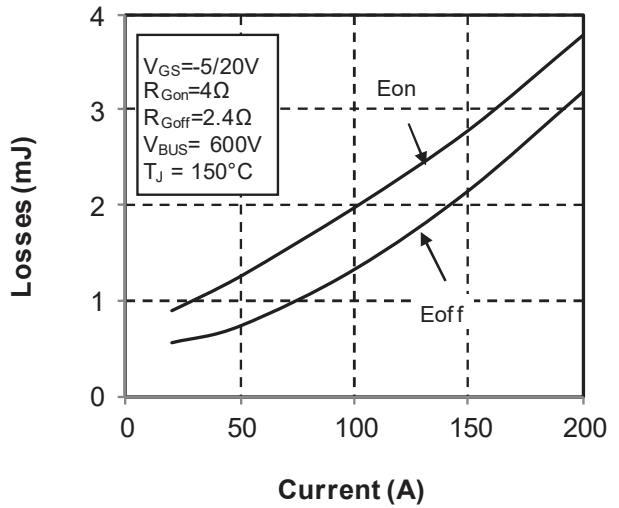


Figure 1-7. Switching Energy vs. Current





# MSCSM120VR1M16CT3AG

## Electrical Specifications

Figure 1-8. Capacitance vs. Drain Source Voltage

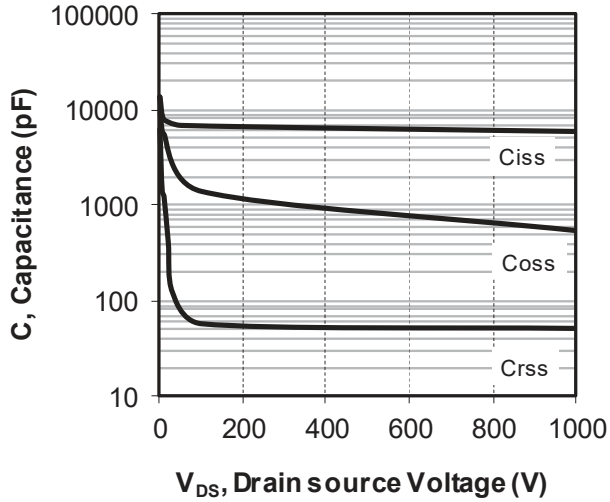


Figure 1-9. Gate Charge vs. Gate Source Voltage

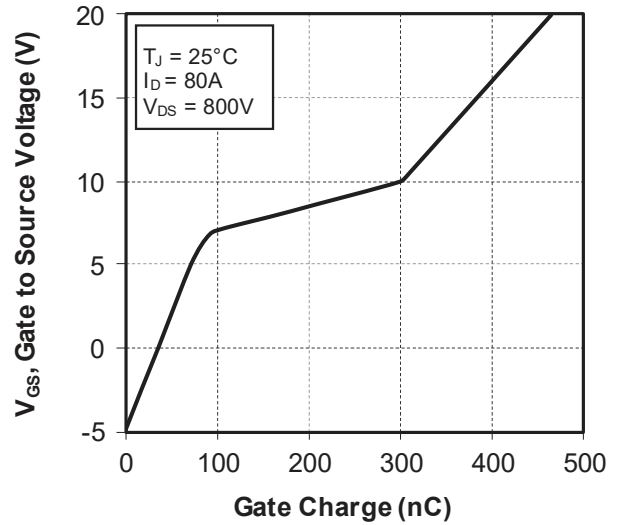


Figure 1-10. Body Diode Characteristics, T<sub>J</sub> = 25 °C

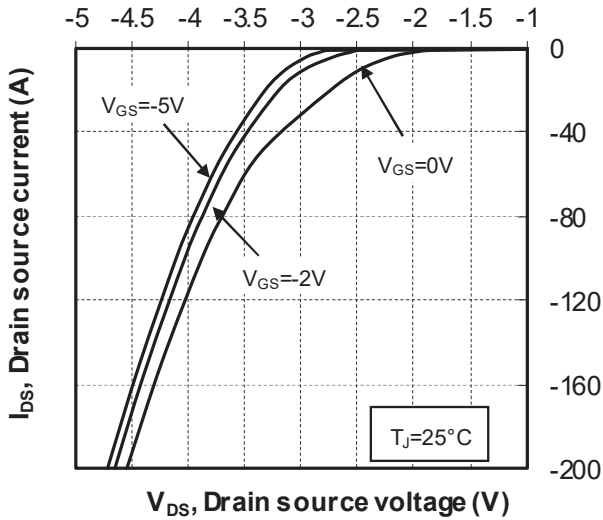
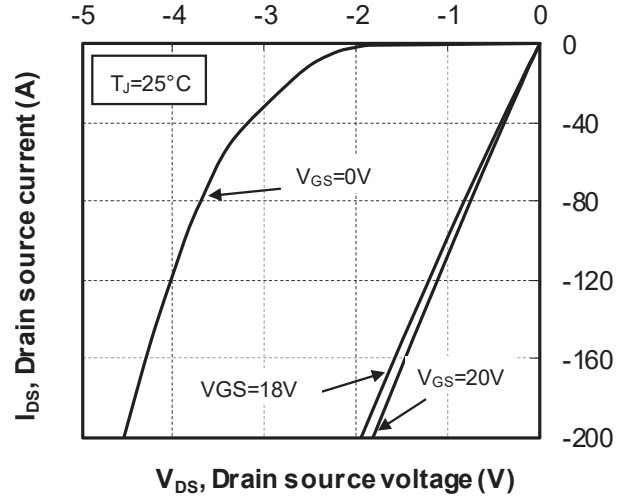


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics, T<sub>J</sub> = 25 °C



# MSCSM120VR1M16CT3AG

## Electrical Specifications

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

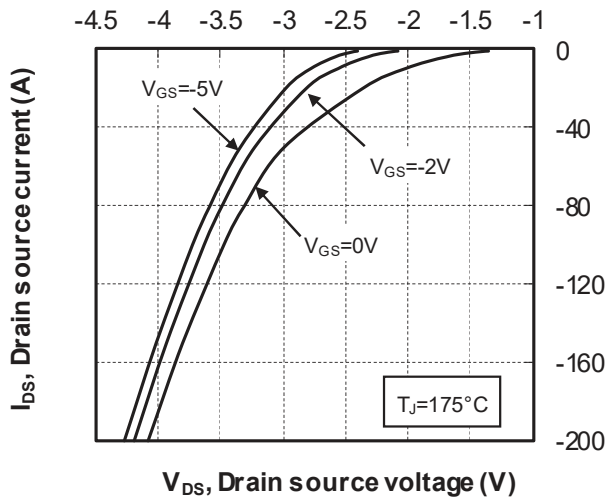


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

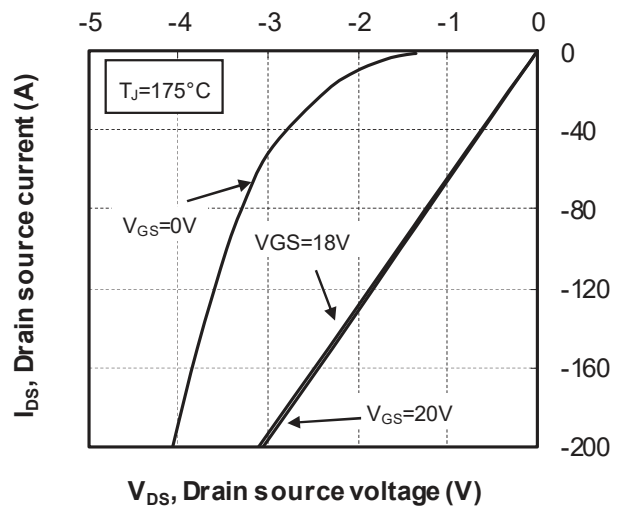
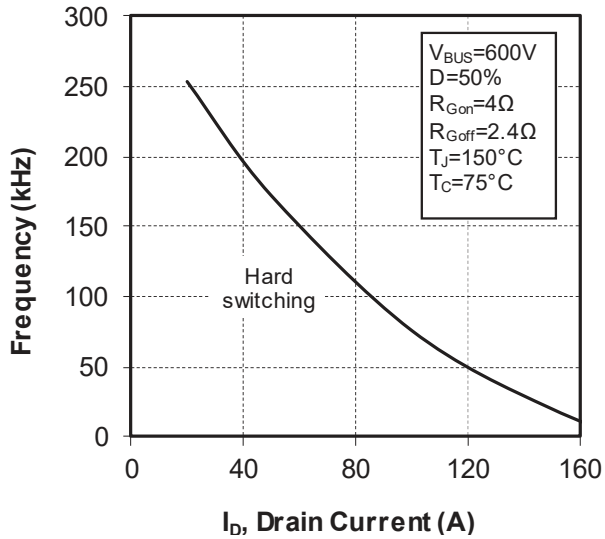


Figure 1-14. Operating Frequency vs. Drain Current



### 1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM120VR1M16CT3AG device.

Figure 1-15. Maximum Thermal Impedance

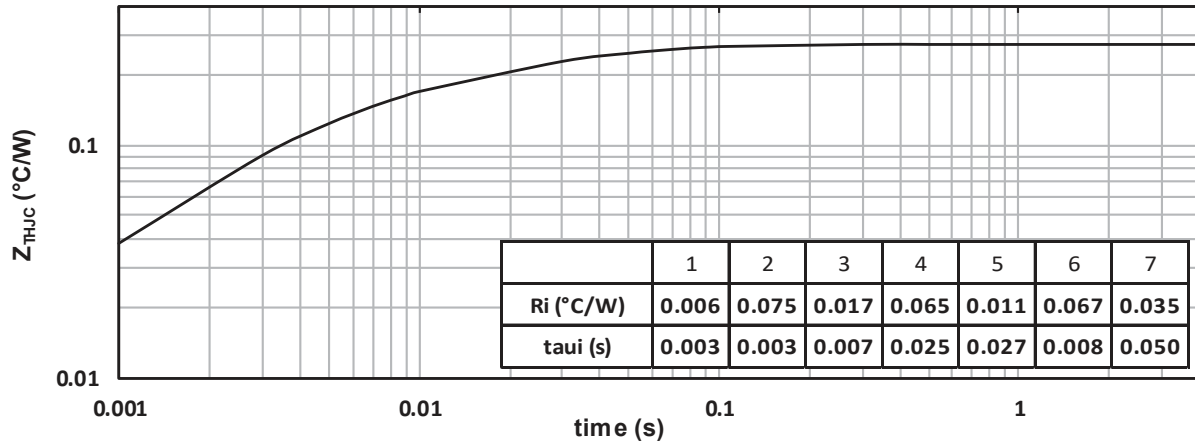


Figure 1-16. Forward Characteristics

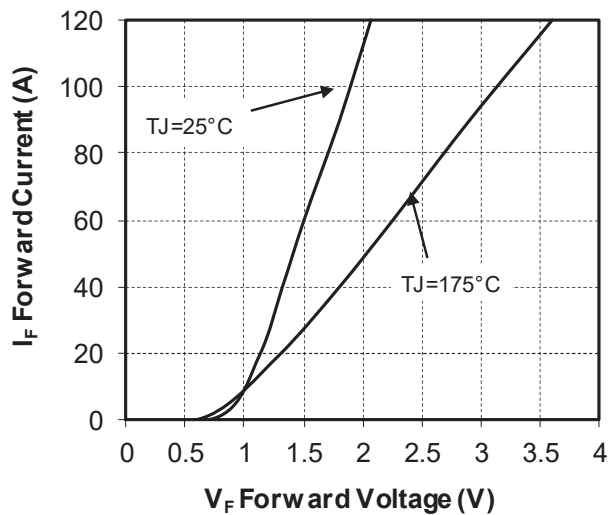
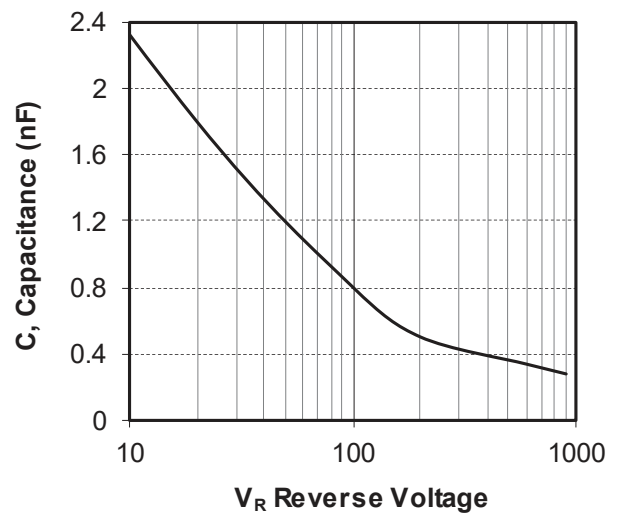


Figure 1-17. Capacitance vs. Reverse Voltage



# MSCSM120VR1M16CT3AG

## Package Specifications

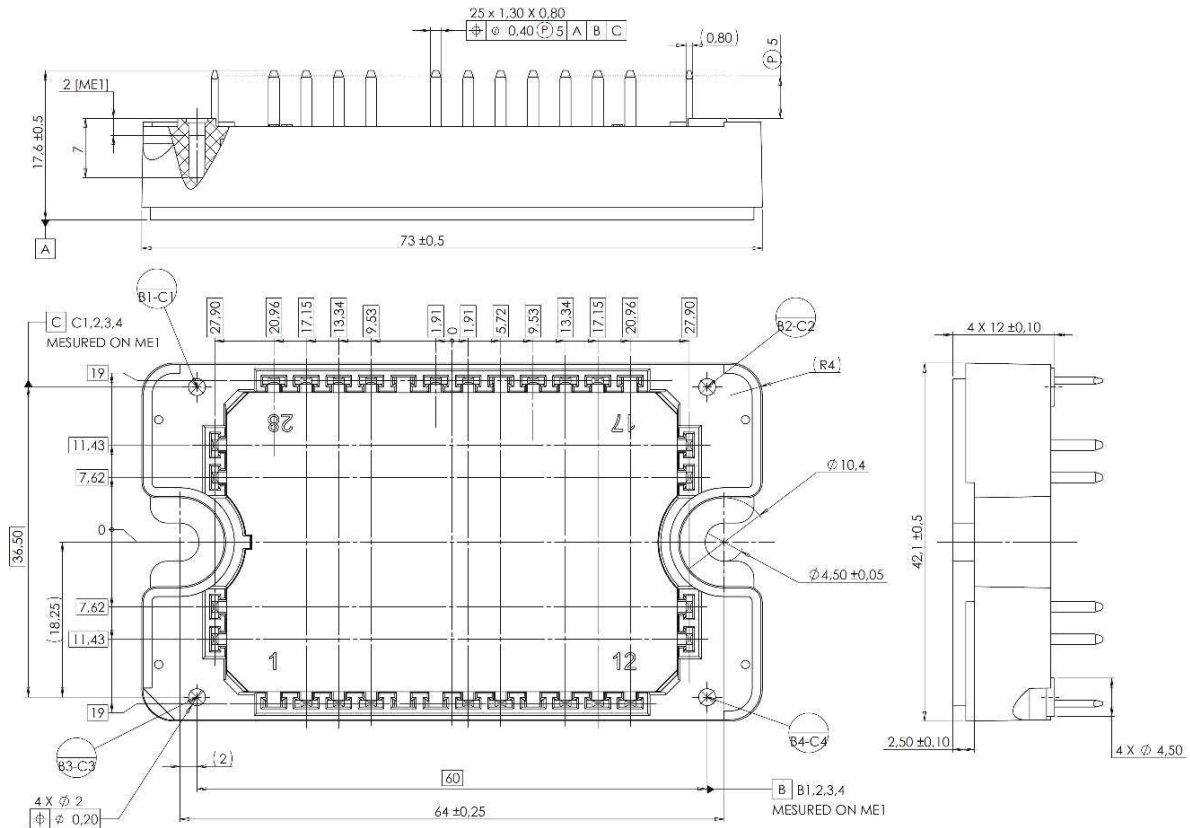
## 2. Package Specifications

The following section shows the package specification of the MSCSM120VR1M16CT3AG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120VR1M16CT3AG 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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