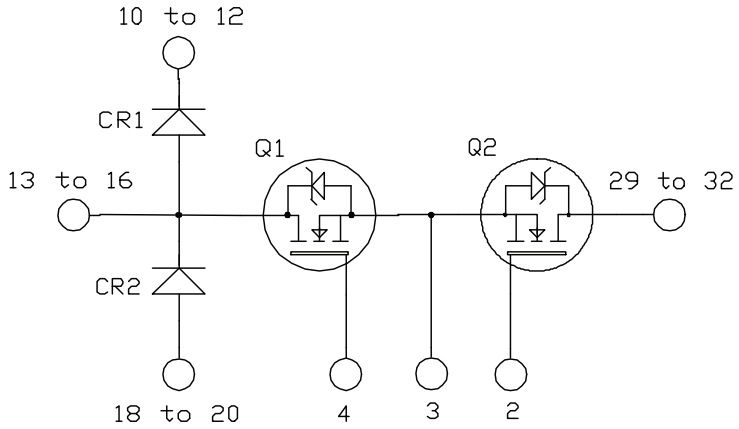
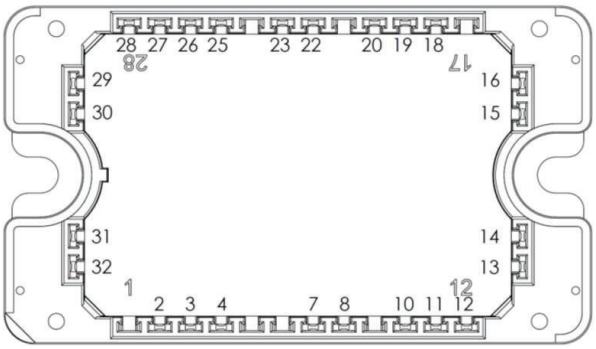
MSCSM70VR1M10CT3AG

Vienna Rectifier SiC MOSFET Power Module

Product Overview

The MSCSM70VR1M10CT3AG device is a Vienna rectifier 700V, 241A silicon carbide (SiC) power module.





Notes:

- All ratings at T_J = 25 °C, unless otherwise specified.
- All multiple inputs and outputs must be shorted together: 10 to 12; 13 to 16; 18 to 20; 29 to 32.

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

Features

The following are key features of the MSCSM70VR1M10CT3AG 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
- Kelvin source for easy drive
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM70VR1M10CT3AG 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

Application

The MSCSM70VR1M10CT3AG device is designed for the following applications:

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

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM70VR1M10CT3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage		700	V
I_D	Continuous drain current	T_C = 25 °C	241[1]	A
		T_C = 80 °C	192[1]	
I_{DM}	Pulsed drain current		482	
V_{GS}	Gate-Source voltage		–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		9.5	mΩ
P_D	Power dissipation	T_C = 25 °C	690	W

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 MSCSM70VR1M10CT3AG 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} = 700V		—	—	200	µA
$R_{DS(on)}$	Drain–Source on resistance	V_{GS} = 20V I_D = 80A	T_J = 25 °C	—	7.5	9.5	mΩ
			T_J = 175 °C	—	9.5	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS} I_D = 8 mA		1.9	2.4	—	V
I_{GSS}	Gate–Source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	200	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70VR1M10CT3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	9000	—	pF
C_{oss}	Output capacitance	V_{DS} = 700V		—	1020	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	58	—	
Q_g	Total gate charge	V_{GS} = –5V/20V		—	430	—	nC
Q_{gs}	Gate-Source charge	V_{Bus} = 470V		—	116	—	
Q_{gd}	Gate-Drain charge	I_D = 80A		—	70	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V	T_J = 150 °C	—	40	—	ns
T_r	Rise time	V_{Bus} = 400V		—	35	—	
$T_{d(off)}$	Turn-off delay time	I_D = 160A		—	50	—	
T_f	Fall time	$R_{G(on)}$ = 13.5Ω $R_{G(off)}$ = 2.4Ω			20	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V	T_J = 150 °C	—	1090	—	µJ
E_{off}	Turn-off energy	V_{Bus} = 400V I_D = 160A $R_{G(on)}$ = 13.5Ω $R_{G(off)}$ = 2.4Ω	T_J = 150 °C	—	372	—	
R_{Gint}	Internal gate resistance			—	2.8	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.217	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM70VR1M10CT3AG 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	—	3.4	—	V
		V_{GS} = –5V; I_{SD} = 80A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 80A; V_{GS} = –5V	—	38	—	ns
Q_{rr}	Reverse recovery charge	V_R = 400V; di_F/dt = 2000 A/µs	—	636	—	nC
I_{rr}	Reverse recovery current		—	29.6	—	A

1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of MSCSM70VR1M10CT3AG device.

Table 1-5. 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 = 1200V	T_J = 25 °C	—	30	400	µA
			T_J = 175 °C	—	500	—	
I_F	DC forward current		T_C = 100 °C	—	100	—	A
V_F	Diode forward voltage	I_F = 100A	T_J = 25 °C	—	1.5	1.8	V
			T_J = 175 °C	—	2.1	—	
Q_C	Total capacitive charge	V_R = 600V		—	448	—	nC
C	Total capacitance	f = 1 MHz V_R = 400V		—	492	—	pF
		f = 1 MHz V_R = 800V		—	364	—	
R_{thJH}	Junction-to-case thermal resistance			—	—	0.297	°C/W

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM70VR1M10CT3AG 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 temperature range			–40	125	
T_C	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 MSCSM70VR1M10CT3AG device.

Table 1-7. Temperature Sensor NTC

Symbol	Characteristic		Min.	Typ.	Max.	Unit
R_{25}	Resistance at 25 °C		—	50	—	kΩ
$\Delta R_{25}/R_{25}$	—	—	—	5	—	%
$B_{25/85}$	T_{25} = 298.15 K	—	—	3952	—	K
ΔB/B	—	T_C = 100 °C	—	4	—	%

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

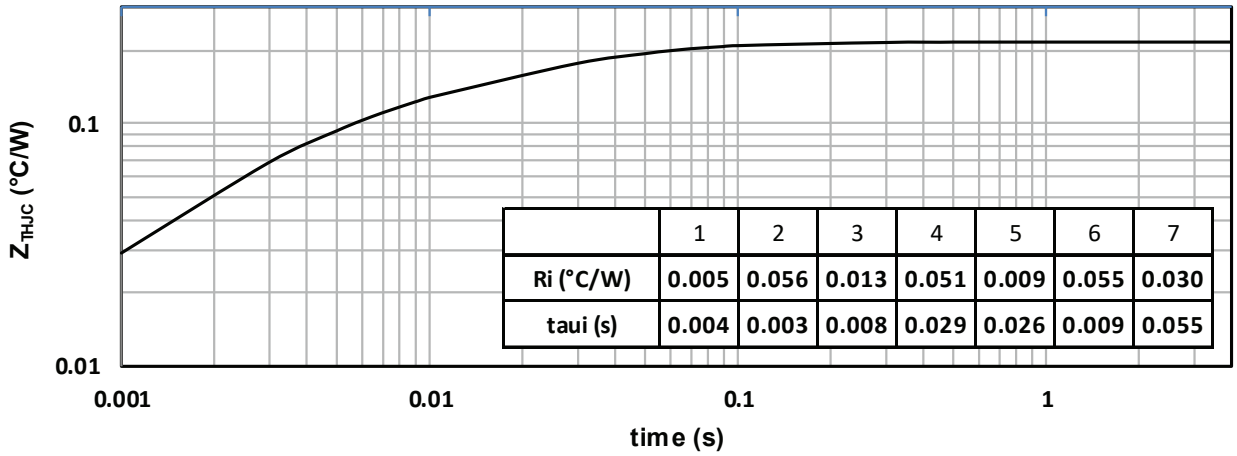
T: Thermistor temperature
R_T: Thermistor value at T

Note: See APT0406—Using NTC Temperature Sensor Integrated into Power Module for more information.

1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70VR1M10CT3AG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.005	0.056	0.013	0.051	0.009	0.055	0.030
taui (s)	0.004	0.003	0.008	0.029	0.026	0.009	0.055

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

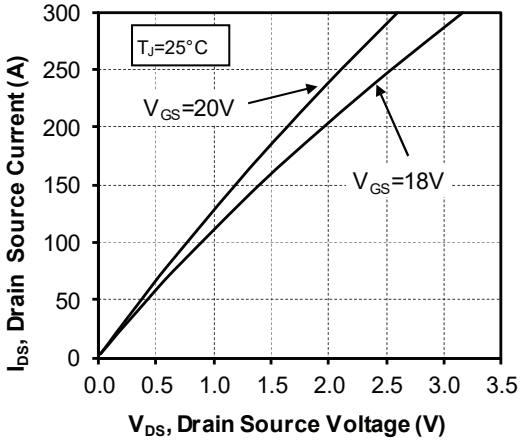


Figure 1-3. Output Characteristics, T_J = 175 °C

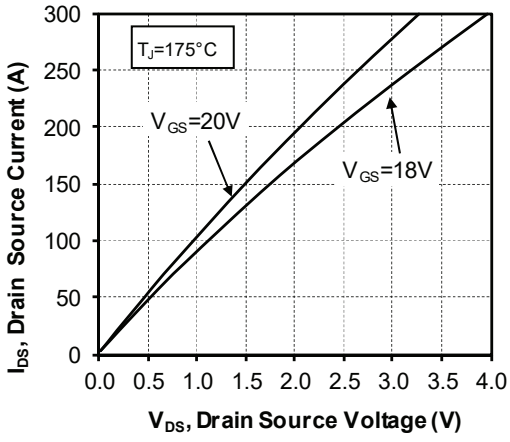


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

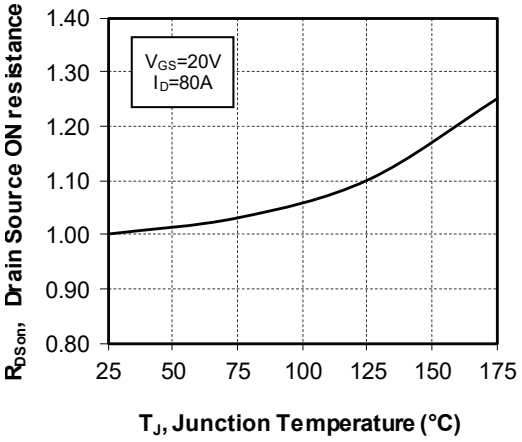


Figure 1-5. Transfer Characteristics

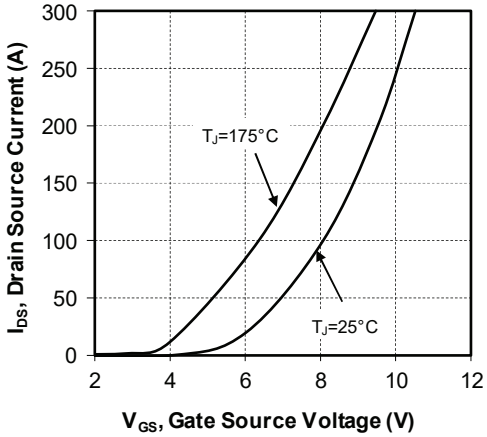


Figure 1-6. Switching Energy vs. Current

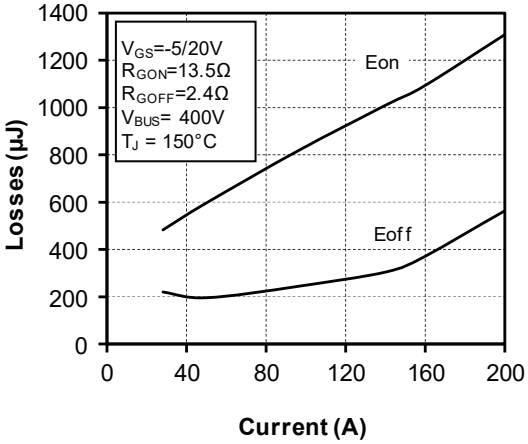


Figure 1-7. Turn On Energy vs. Rg

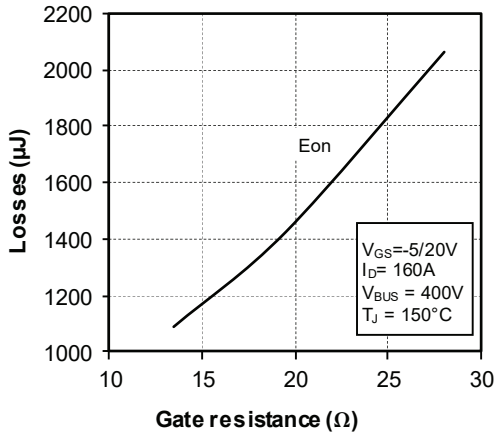


Figure 1-8. Capacitance vs. Drain Source Voltage

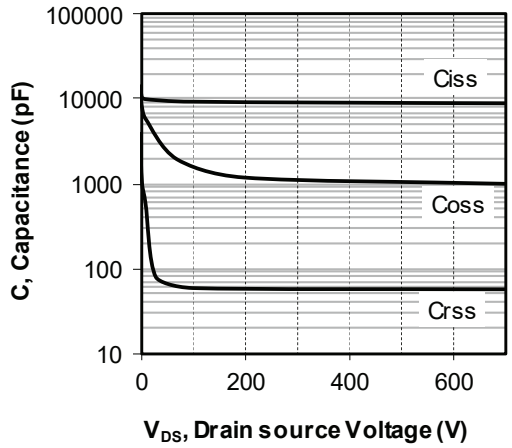


Figure 1-9. Gate Charge vs. Gate Source Voltage

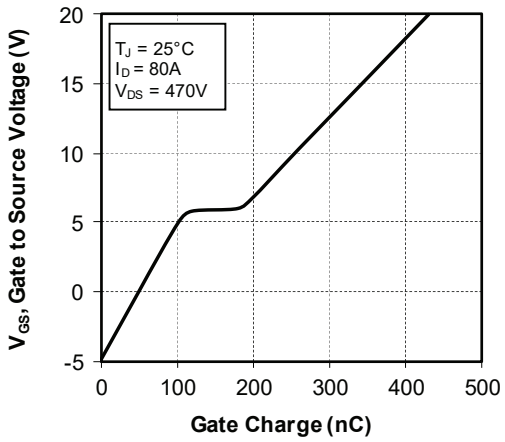


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

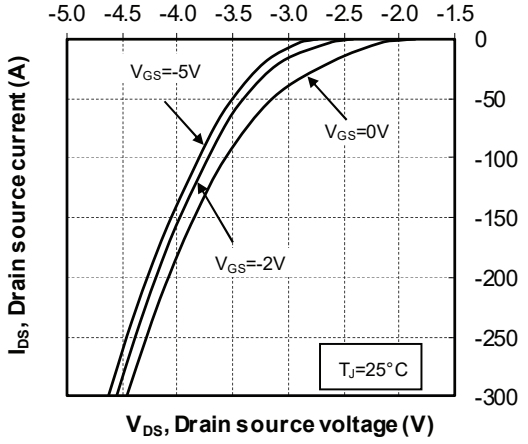


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

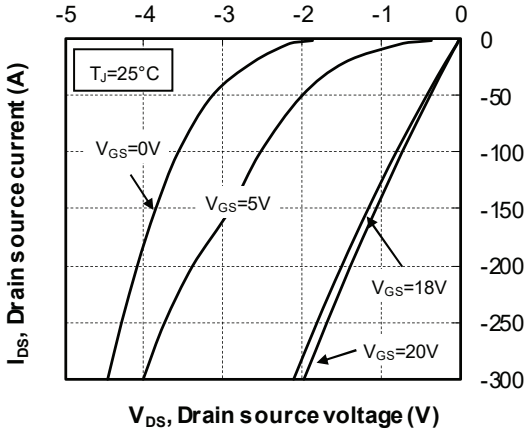


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

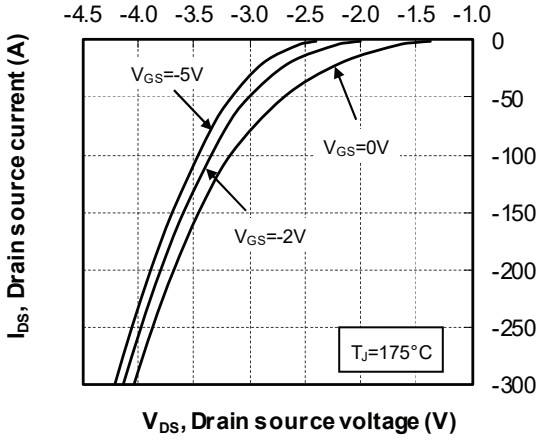


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

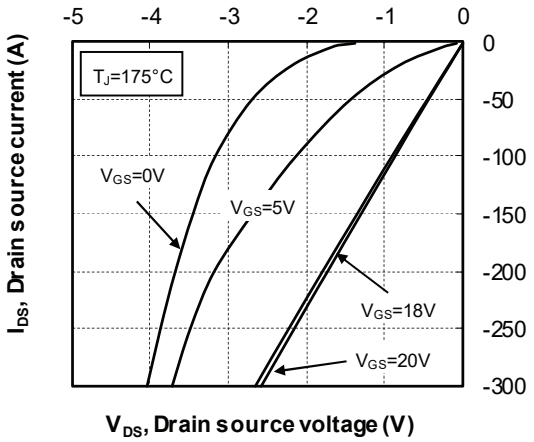


Figure 1-14. Operating Frequency vs Drain Current

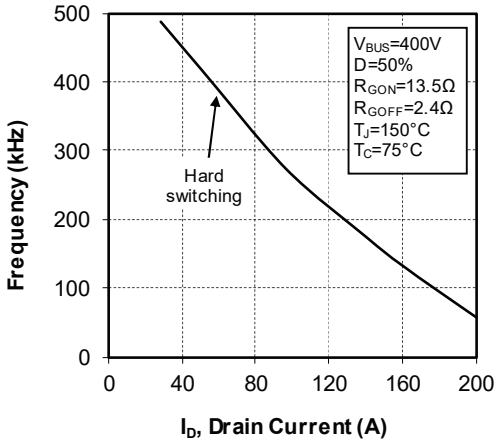
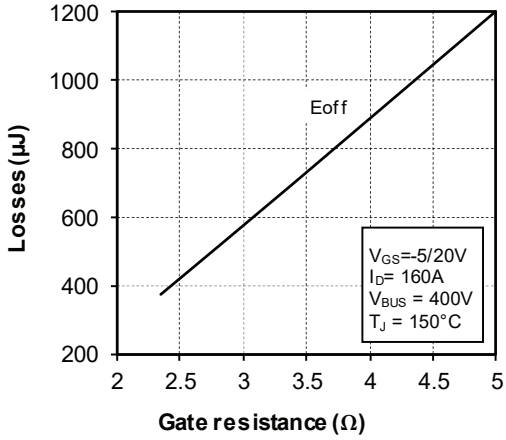


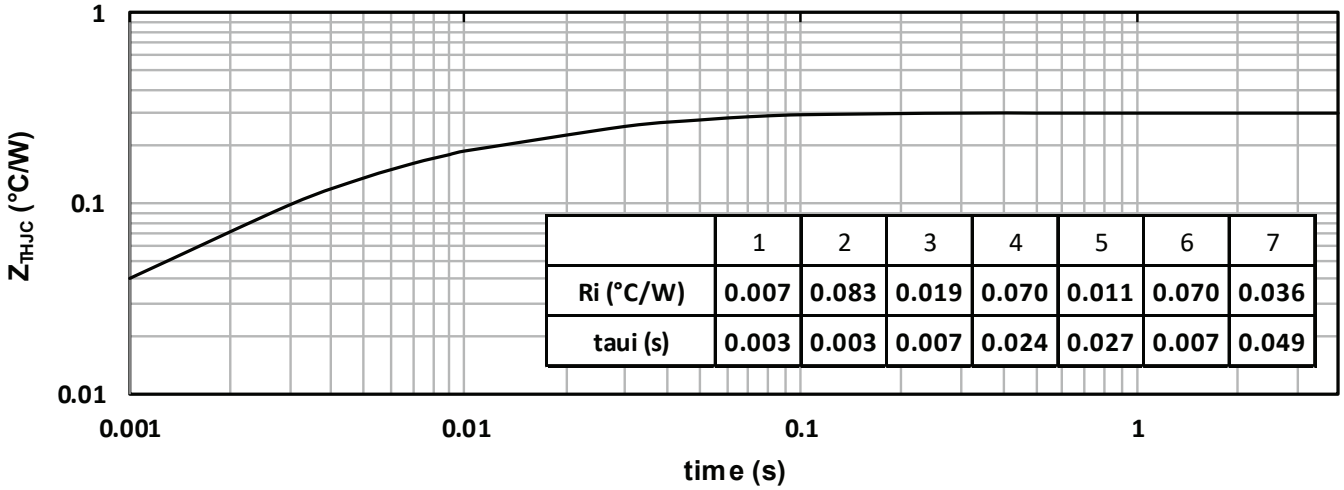
Figure 1-15. Turn Off Energy vs. Rg



1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM70VR1M10CT3AG device.

Figure 1-16. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.007	0.083	0.019	0.070	0.011	0.070	0.036
taui (s)	0.003	0.003	0.007	0.024	0.027	0.007	0.049

Figure 1-17. Forward Characteristics

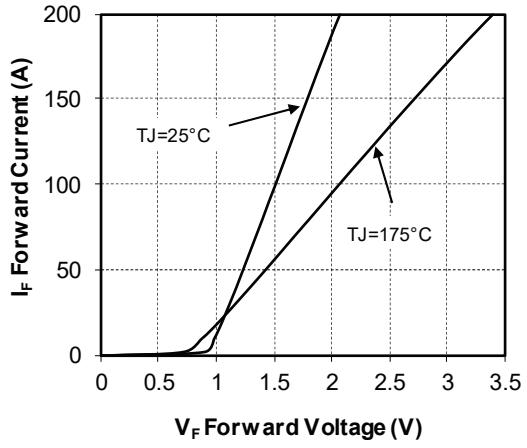
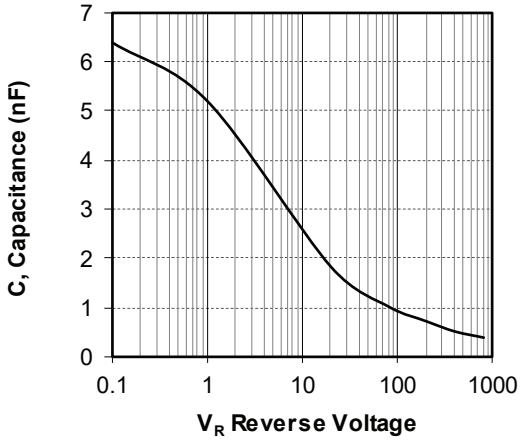


Figure 1-18. Capacitance vs. Reverse Voltage



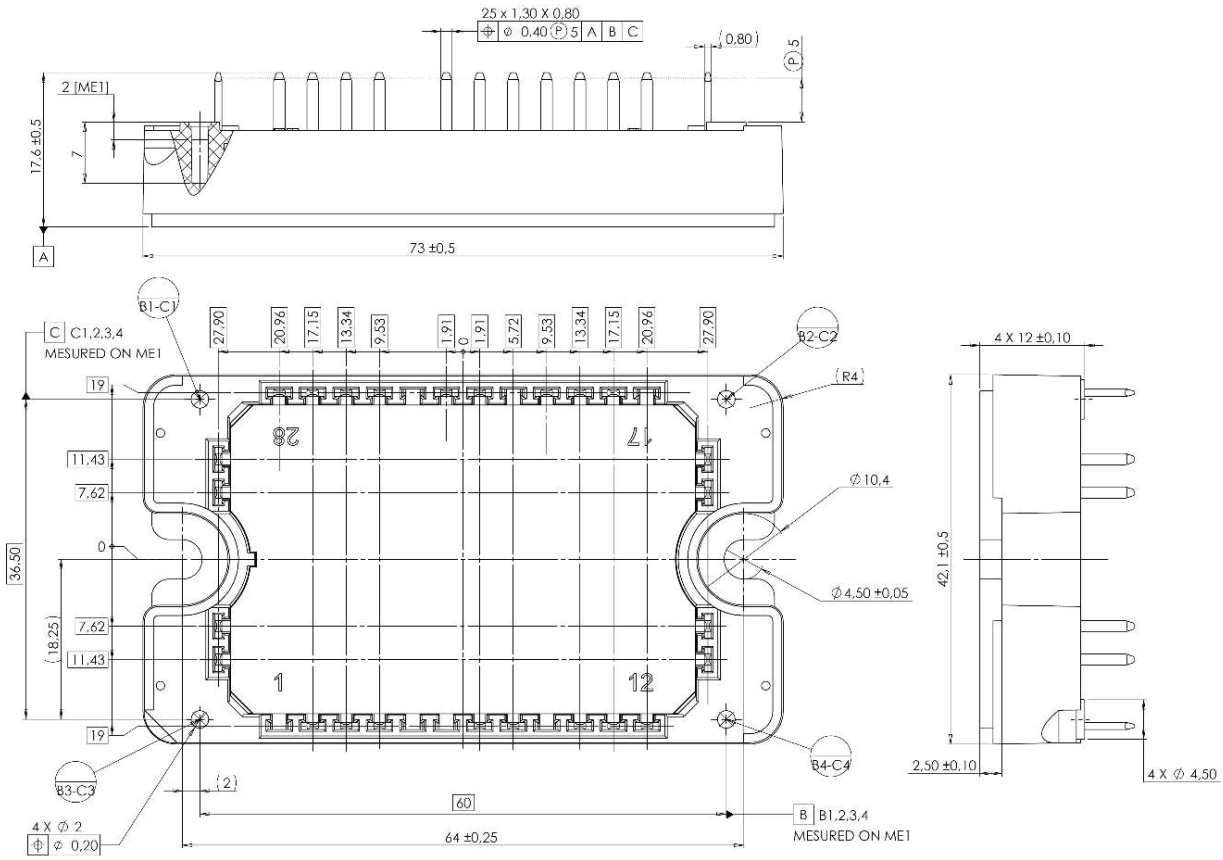
2. Package Specifications

The following section shows the package specification of the MSCSM70VR1M10CT3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70VR1M10CT3AG 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 application note for more information.

3. Revision History

Revision	Date	Description
A	08/2022	Initial Revision

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