Phase Leg SiC MOSFET Power Module

MSCSM70AM07CT3AG

Product Overview

The MSCSM70AM07CT3AG device is a phase leg 700V, 353A Silicon Carbide (SiC) power module.

The following figures show the electrical diagram and pinout location of the device.

Figure 1. Electrical Diagram

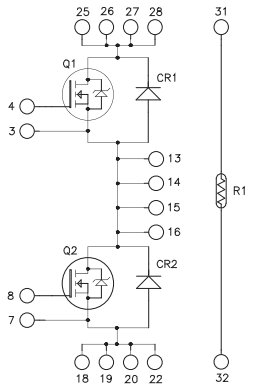
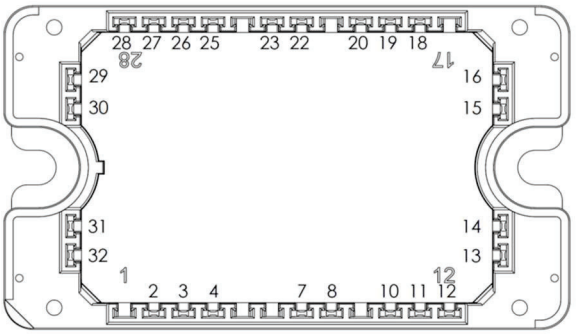


Figure 2. Pinout Location



Notes:

- Pins 25 to 28 must be shorted together
- Pins 13 to 16 must be shorted together
- Pins 18, 19, 20, and 22 must be shorted together
- All ratings at T_J = 25 °C, unless otherwise specified

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

Features

The MSCSM70AM07CT3AG device has the following key features:

- 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
- Internal thermistor for temperature monitoring
- AlN substrate for improved thermal performance

Benefits

The MSCSM70AM07CT3AG device has the following benefits:

- High efficiency converter
- 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 MSCSM70AM07CT3AG device has the following applications:

- Welding converters
- Switched mode power supplies
- Uninterruptible power supplies
- Electric Vehicle (EV) motor and traction drive

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM70AM07CT3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM70AM07CT3AG 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	353[1]	A
		T_C = 80 °C	281[1]	
I_{DM}	Pulsed drain current		700	
V_{GS}	Gate-source voltage		−10/23	V
$R_{DS(on)}$	Drain-source ON resistance		6.4	mΩ
P_D	Power dissipation	T_C = 25 °C	988	W

Note:

1. The specification of the SiC MOSFET device, but output current must be limited due to the size of the power connectors.

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM70AM07CT3AG 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		—	—	300	µA
$R_{DS(on)}$	Drain-source ON resistance	V_{GS} = 20V I_D = 120A	T_J = 25 °C	—	5	6.4	mΩ
			T_J = 175 °C	—	6.3	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 12 mA		1.9	2.4	—	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	300	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM70AM07CT3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	13.5	—	nF
C_{oss}	Output capacitance	V_{DS} = 700V		—	1.5	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.09	—	
Q_g	Total gate charge	V_{GS} = −5V/20V		—	645	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 470V		—	174	—	
Q_{gd}	Gate-drain charge	I_D = 120A		—	105	—	
$T_{d(on)}$	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 = 240A		—	50	—	
T_f	Fall time	R_{GON} = 9Ω		—	20	—	
		R_{GOFF} = 1.6Ω					
E_{on}	Turn-on energy	V_{GS} = −5V/20V	T_J = 150 °C	—	1.6	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400V		—	0.56	—	
		I_D = 240A					
		R_{GON} = 9Ω					
		R_{GOFF} = 1.6Ω					
R_{Gint}	Internal gate resistance			—	1.9	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.152	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM70AM07CT3AG 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} = 120A	—	3.4	—	V
		V_{GS} = –5V; I_{SD} = 120A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 120A	—	38	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = −5V	—	954	—	nC
I_{rr}	Reverse recovery current	V_R = 470V	—	44	—	A
		di_F/dt = 3000 A/µs				

1.2 SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the diode ratings and characteristics (per SiC diode) of the MSCSM70AM07CT3AG device.

Table 1-5. Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	700	V
I_{RRM}	Reverse leakage current	V_R = 700V	T_J = 25 °C	—	45	600	µA
			T_J = 175 °C	—	750	—	
I_F	DC forward current		T_C = 70 °C	—	150	—	A
V_F	Diode forward voltage	I_F = 150A	T_J = 25 °C	—	1.5	1.8	V
			T_J = 175 °C	—	1.9	—	
Q_C	Total capacitive charge	V_R = 400V		—	399	—	nC
C	Total capacitance	f = 1 MHz V_R = 200V		—	744	—	pF
		f = 1 MHz V_R = 400V		—	648	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.318	°C/W

1.3 Temperature Sensor NTC

The following table lists the temperature sensor NTC of the MSCSM70AM07CT3AG device.

Table 1-6. 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} = 298.15K		—	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: For more information, see APT0406—Using NTC Temperature Sensor Integrated into Power Module.

1.4 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM70AM07CT3AG device.

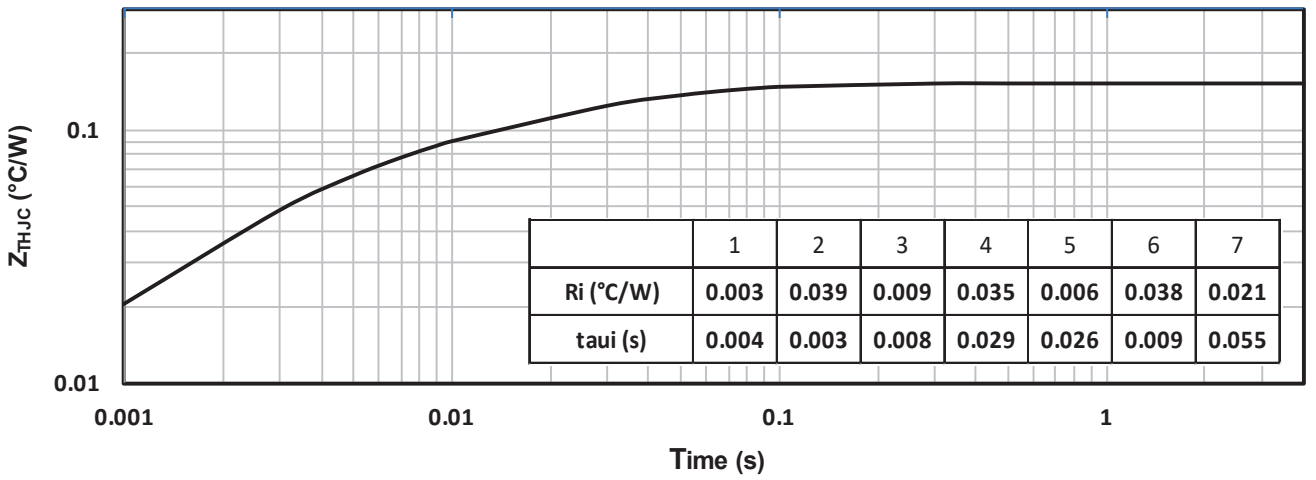
Table 1-7. Thermal and Package Characteristics

Symbol	Characteristic			Min.	Max.	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50/60 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

1.5 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM70AM07CT3AG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.003	0.039	0.009	0.035	0.006	0.038	0.021
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

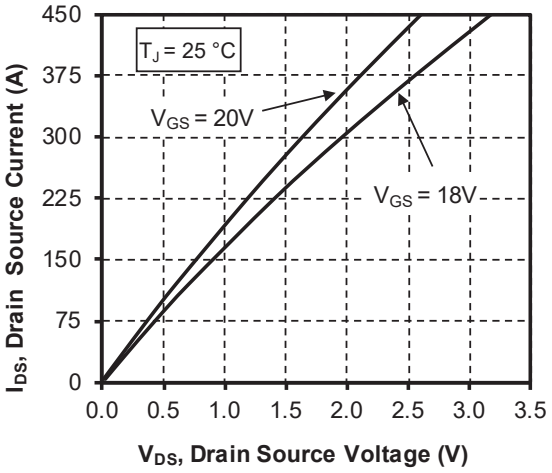


Figure 1-3. Output Characteristics, T_J = 175 °C

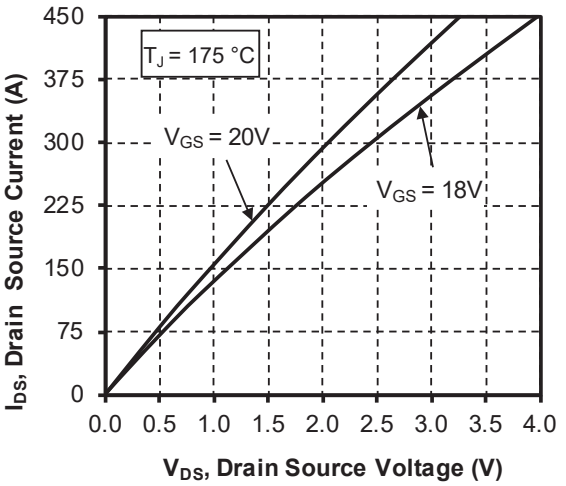


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

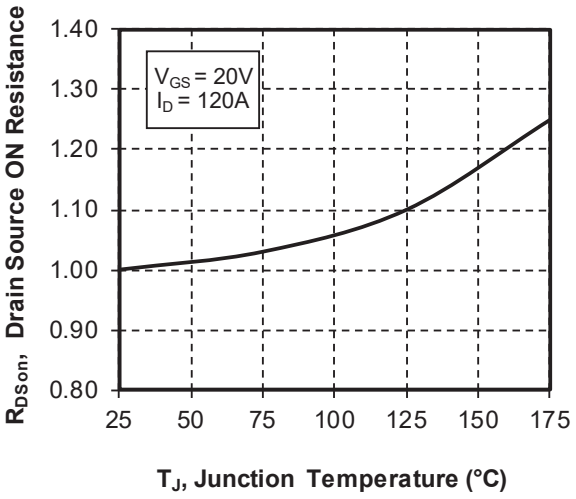


Figure 1-5. Transfer Characteristics

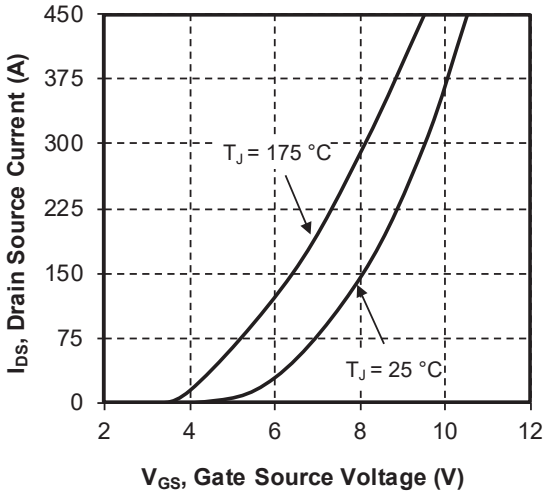


Figure 1-6. Capacitance vs. Drain Source Voltage

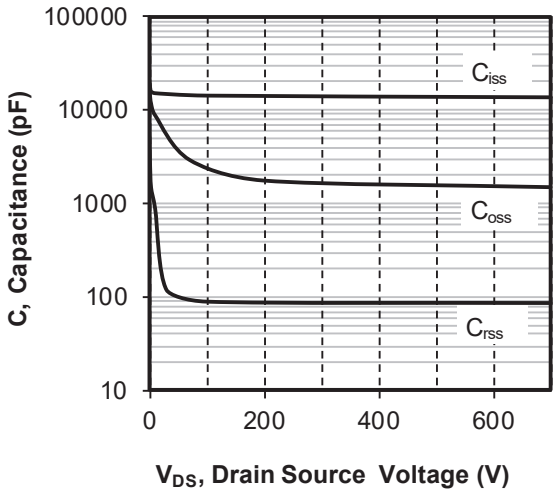


Figure 1-7. Gate Charge vs. Gate Source Voltage

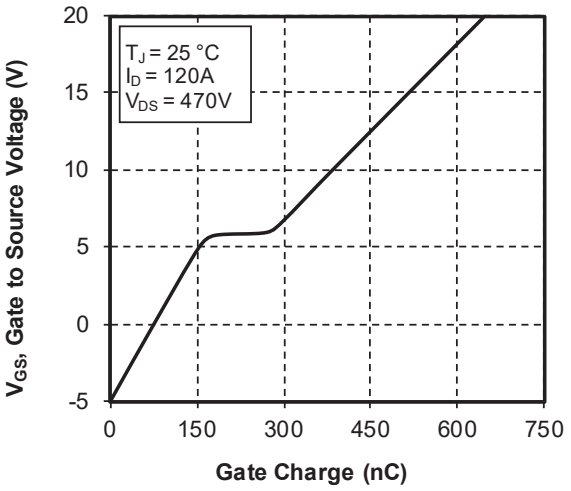


Figure 1-8. Body Diode Characteristics, T_J = 25 °C

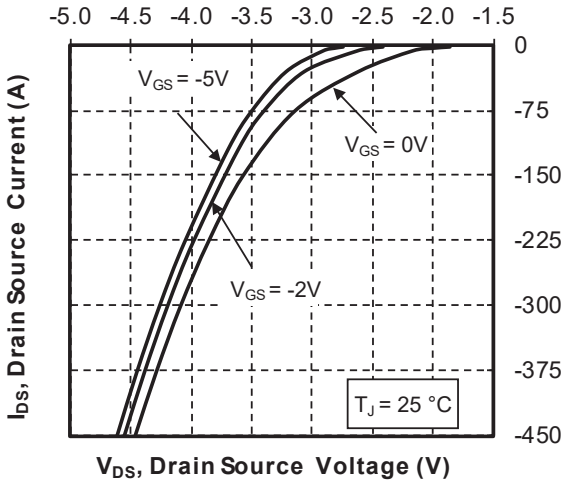


Figure 1-9. 3rd Quadrant Characteristics, T_J = 25 °C

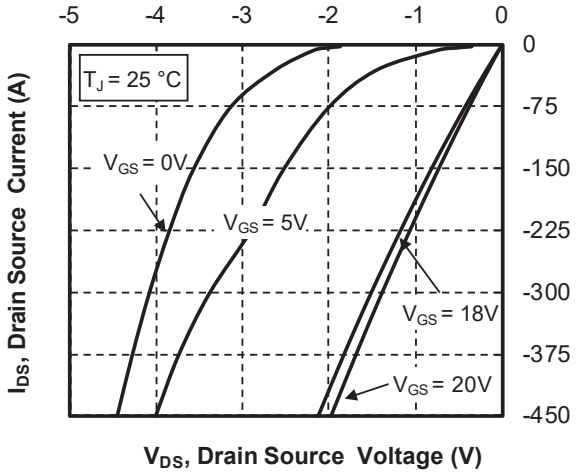


Figure 1-10. Body Diode Characteristics, T_J = 175 °C

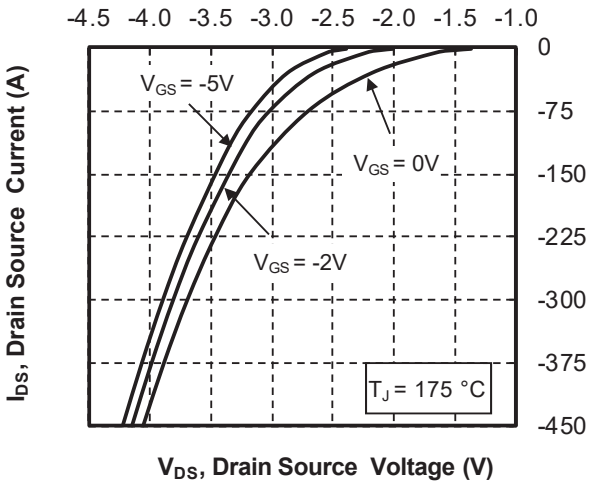


Figure 1-11. 3rd Quadrant Characteristics, T_J = 175 °C

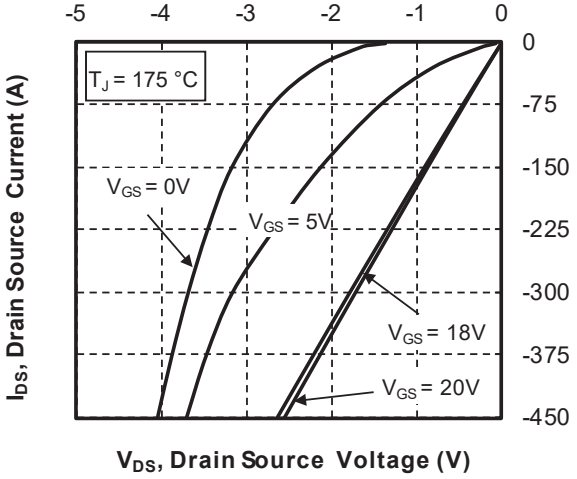


Figure 1-12. Switching Energy vs. Current

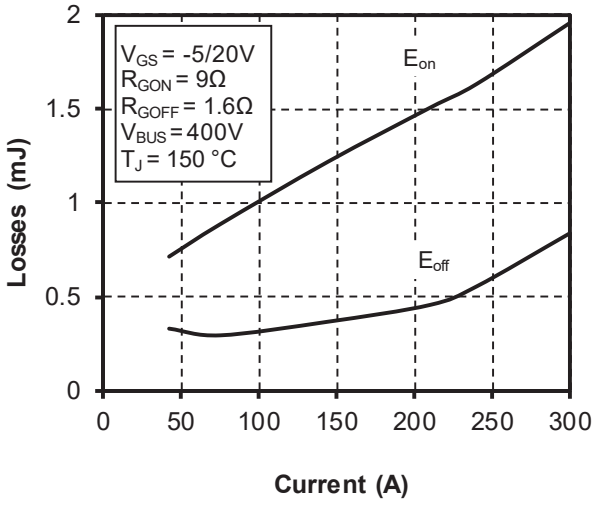


Figure 1-13. Turn-On Energy vs. Rg

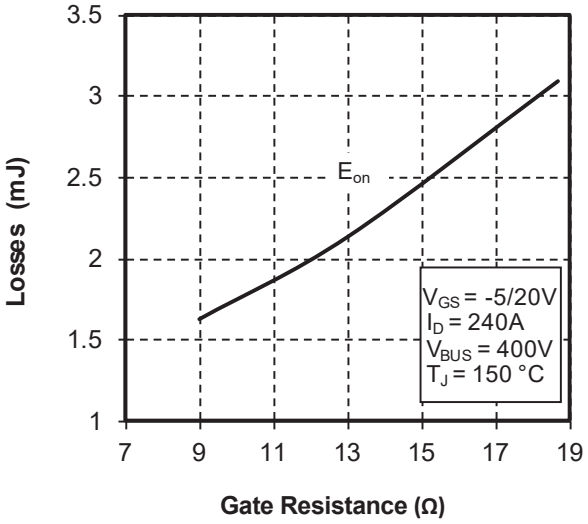


Figure 1-14. Turn-Off Energy vs. Rg

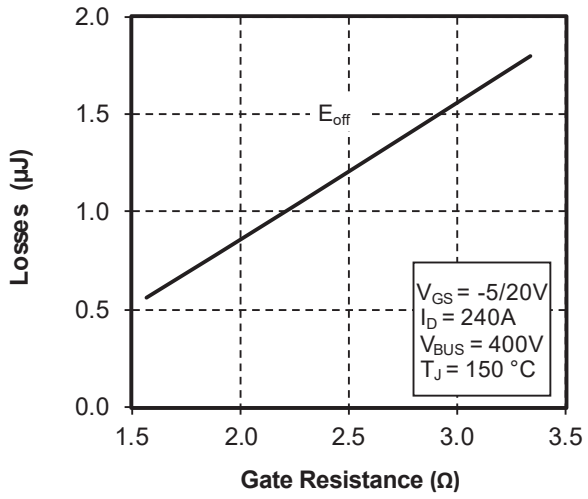
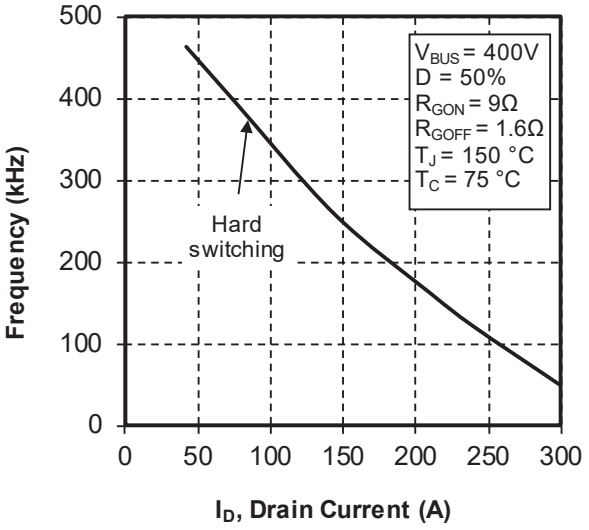


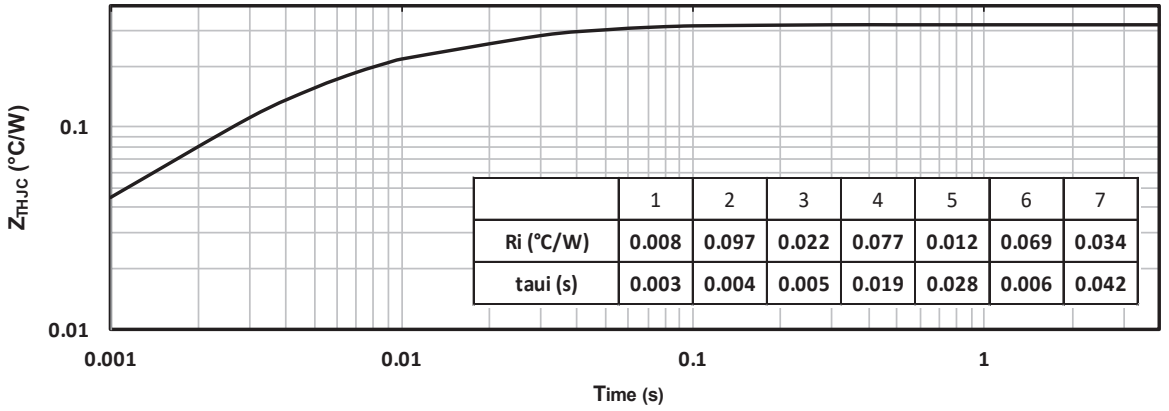
Figure 1-15. Operating Frequency vs. Drain Current



1.6 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM70AM07CT3AG device.

Figure 1-16. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.008	0.097	0.022	0.077	0.012	0.069	0.034
taui (s)	0.003	0.004	0.005	0.019	0.028	0.006	0.042

Figure 1-17. Forward Characteristics

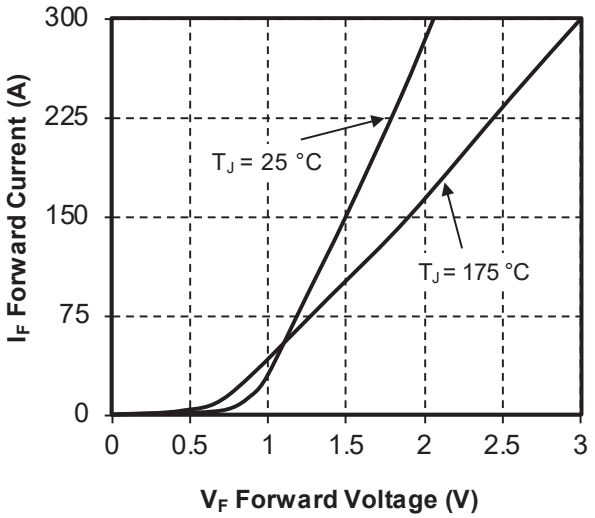
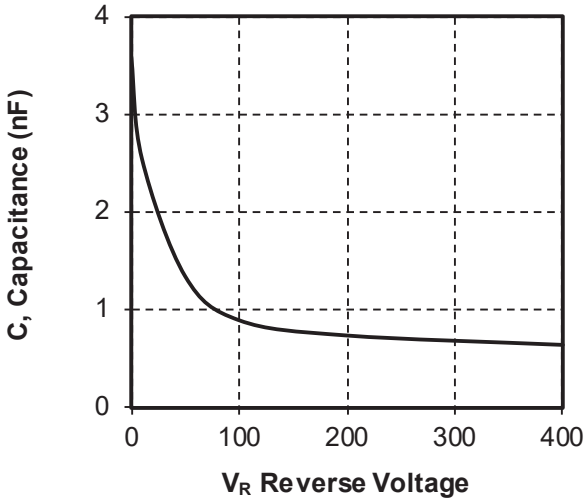


Figure 1-18. Capacitance vs. Reverse Voltage



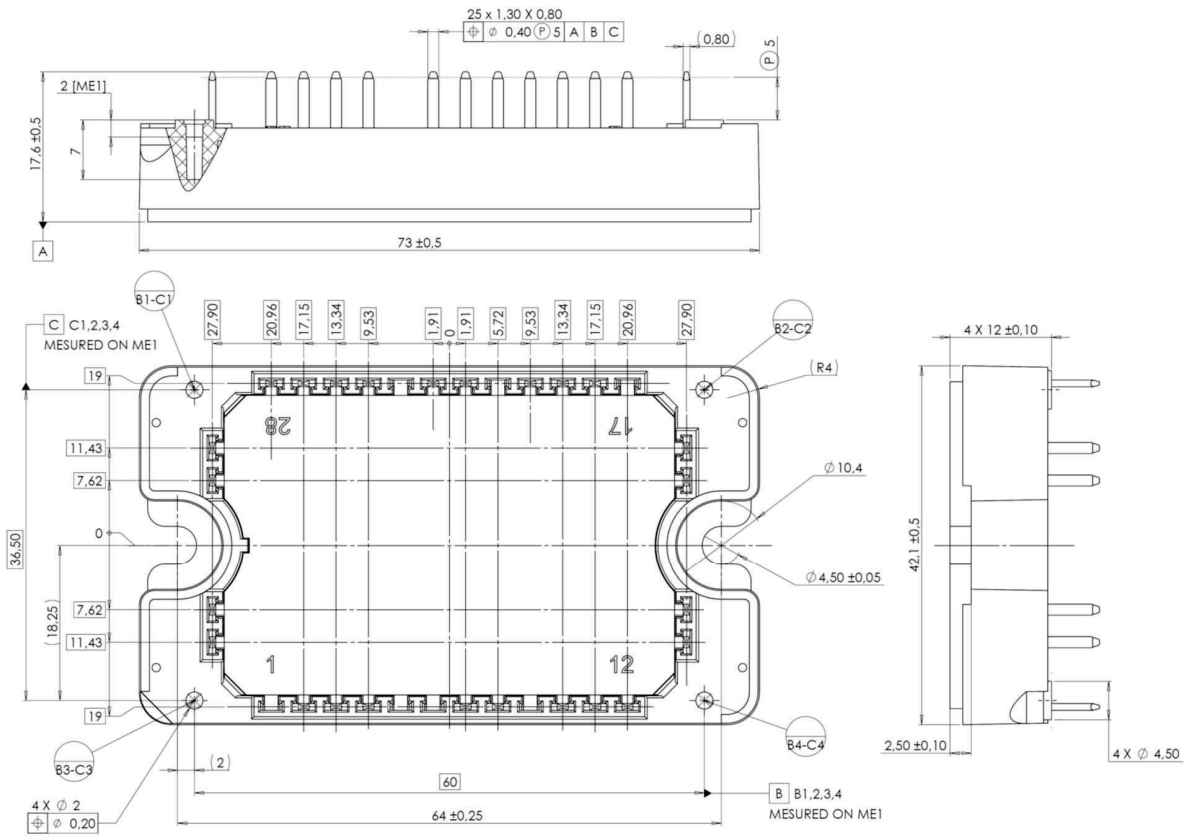
2. Package Specifications

The following section shows the package specification of the MSCSM70AM07CT3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70AM07CT3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: For more information, see application note AN3500A-Mounting Instructions for SP1F and SP3F Power Modules.

3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
A	06/2023	Initial revision

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