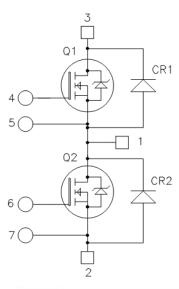
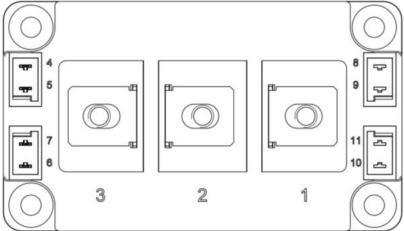
MSCSM170AM039CD3AG

Phase Leg SiC Power Module

Product Overview

The MSCSM170AM039CD3AG device is a 1700 V/523 A phase leg silicon carbide (SiC) power module.





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 following are the key features of MSCSM170AM039CD3AG 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 VF
- Kelvin emitter for easy drive
- · High level of integration
- · M6 power connectors
- · Aluminum Nitride (AIN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM170AM039CD3AG device:

- · High efficiency converter
- · Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- · Low junction-to-case thermal resistance
- RoHS Compliant

Applications

The following are the applications of MSCSM170AM039CD3AG device:

- · Welding converters
- · Switched mode power supplies
- Uninterruptible power supplies
- EV motor and traction drive

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM170AM039CD3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM170AM039CD3AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Parameter		
V _{DSS}	Drain-Source voltage	Drain-Source voltage		V
I _D	Continuous drain current	T _C = 25 °C	523	Α
		T _C = 80 °C	416	
I _{DM}	Pulsed drain current	Pulsed drain current		
V _{GS}	Gate-Source voltage	Gate-Source voltage		V
R _{DS(on)}	Drain-Source ON resistance	Drain-Source ON resistance		mΩ
P _D	Power dissipation	T _C = 25 °C	2400	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM170AM039CD3AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Тур	Max	Unit
I _{DSS}	Zero gate voltage drain current	V _{GS} = 0 V; V _{DS} = 1700 V		_	90	900	μΑ
R _{DS(on)}	Drain-Source on	V _{GS} = 20 V	T _J = 25 °C	_	3.9	5	mΩ
	resistance	I _D = 270 A	T _J = 175 °C	_	6.8	_	
V _{GS(th)}	Gate threshold voltage	$V_{GS} = V_{DS}; I_D = 22.5 \text{ mA}$		1.8	3.3	_	V
I _{GSS}	Gate-Source leakage current	V _{GS} = 20 V; V _{DS} = 0 V		_	_	900	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM170AM039CD3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Тур	Max	Unit
C _{iss}	Input capacitance	V _{GS} = 0 V		_	29.7	_	nF
C _{oss}	Output capacitance	V _{DS} = 1000 V		_	1.3	_	
C _{rss}	Reverse transfer capacitance	f = 1 MHz		_	0.09	_	
Qg	Total gate charge	V _{GS} = -5 V/20 V		_	1602	_	nC
Q _{gs}	Gate-source charge	V _{Bus} = 850 V		_	441	_	
Q_{gd}	Gate-drain charge	I _D = 270 A	I _D = 270 A			_	
T _{d(on)}	Turn-on delay time	V _{GS} = -5 V/20 V		_	75	_	ns
T _r	Rise time	V _{Bus} = 900 V	V _{Bus} = 900 V		75	_	
T _{d(off)}	Turn-off delay time	I _D = 450 A		_	153	_	
T _f	Fall time	T_J = 150 °C R_{GON} = 3.2 Ω R_{GOFF} = 1.8 Ω			56	_	
E _{on}	Turn-on energy	V _{GS} = -5 V/20 V	T _J = 150 °C	_	20.3	_	mJ
E _{off}	Turn-off energy	V_{Bus} = 900 V T_{J} = 150 °C I_{D} = 450 A R_{GON} = 3.2 Ω R_{GOFF} = 1.8 Ω		_	10.8		mJ
R _{Gint}	Internal gate resistance				0.65	_	Ω
R _{thJC}	Junction-to-case therr	mal resistance		_	_	0.063	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM170AM039CD3AG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min	Тур	Max	Unit
V _{SD}	Diode forward voltage	V _{GS} = 0 V; I _{SD} = 270 A	_	3.7	_	V
		$V_{GS} = -5 \text{ V}; I_{SD} = 270 \text{ A}$	_	3.9	_	
t _{rr}	Reverse recovery time	I _{SD} = 270 A	_	27	_	ns
Q _{rr}	Reverse recovery charge	$V_{GS} = -5 \text{ V}$	_	5.9	_	μC
I _{rr}	Reverse recovery current	V _R = 900 V di _F /dt = 9000 A/μs	_	414	_	A

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

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM170AM039CD3AG device.

Table 1-5. SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

Symbol	Characteristic	Test Condition	ıs	Min	Тур	Max	Unit
V _{RRM}	Peak repetitive reverse voltage	_		_	_	1700	V
I _{RRM}	Reverse leakage current	V _R = 1700 V	T _J = 25 °C	_	70	1400	μΑ
			T _J = 175 °C	_	1050	_	
I _F	DC forward current	_	T _C = 125 °C	_	210	_	А
V _F	Diode forward voltage	I _F = 210 A	T _J = 25 °C	_	1.5	1.8	V
			T _J = 175 °C	_	2.3	_	
Q _C	Total capacitive charge	V _R = 900 V		_	1610	_	nC
С	Total capacitance	ce $f = 1 \text{ MHz}, V_R = 600 \text{ V}$ $f = 1 \text{ MHz}, V_R = 900 \text{ V}$		_	1169	_	pF
				_	966	_	
R _{thJC}	Junction-to-case thermal re	sistance		_		0.09	°C/W

1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM170AM039CD3AG device.

Table 1-6. Thermal and Package Characteristics

Symbol	Characteristic	Characteristic				
V _{ISOL}	RMS isolation voltage, any terminal to ca	se t = 1 min, 5	0 Hz/60 Hz	4000	_	V
T _J	Operating junction temperature range			-40	175	°C
T _{JOP}	Recommended junction temperature und	er switching co	onditions	-40	T _{Jmax} –25	
T _{STG}	Storage case temperature	-40	125			
T _C	Operating case temperature	Operating case temperature				
Torque	Mounting torque	For terminals	M6	3	5	N.m
		To heatsink	M6	3	5	
Wt	Package weight				350	g

1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM170AM039CD3AG device.

Figure 1-1. Maximum Thermal Impedance

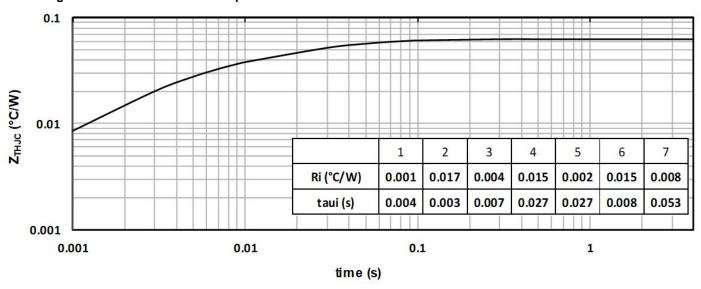


Figure 1-2. Output Characteristics, $T_J = 25$ °C

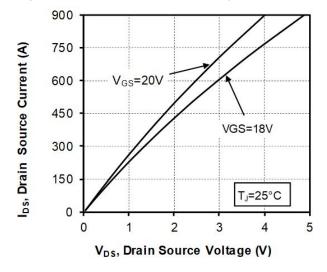


Figure 1-3. Output Characteristics, T_J = 175 °C

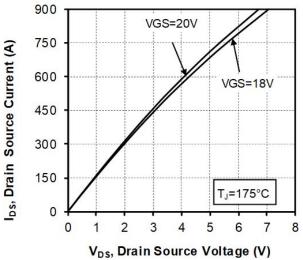


Figure 1-4. Normalized R_{DS(on)} vs. Temperature

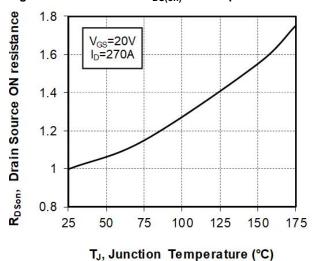


Figure 1-5. Transfer Characteristics

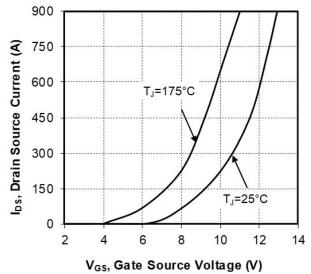


Figure 1-6. Switching Energy vs. Rg

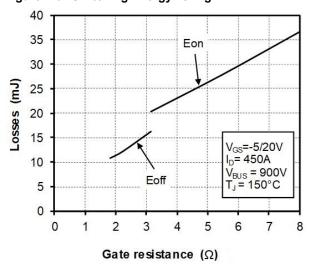


Figure 1-7. Switching Energy vs. Current

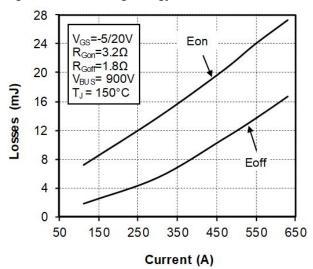


Figure 1-8. Capacitance vs. Drain Source Voltage

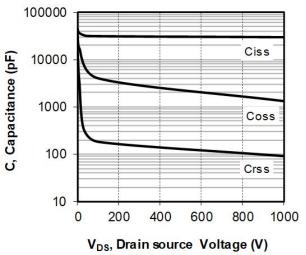


Figure 1-9. Gate Charge vs. Gate Source Voltage

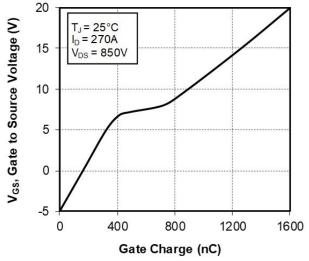


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

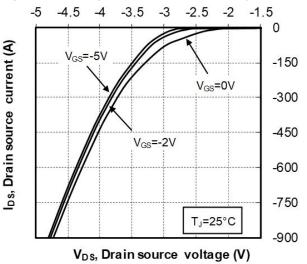
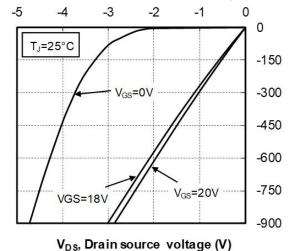


Figure 1-11. 3^{rd} Quadrant Characteristics, $T_J = 25$ °C



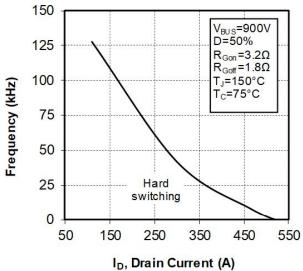
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current (A)

Drain source

Figure 1-12. Body Diode Characteristics, T_J = 175 °C Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 0 IDS, Drain source current (A) V_{GS}=-5V T_J=175°C l_{DS}, Drain source current (A) -150 -150 V_{GS}=-2V -300 -300 V_{GS}=0V -450 -450 V_{GS}=20V VGS=18V -600 -600 -750 -750 T₁=175°C V_{GS}=0V -900 -900 V_{DS}, Drain source voltage (V) V_{DS}, Drain source voltage (V)

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 MSCSM170AM039CD3AG device.

Figure 1-15. Maximum Thermal Impedance

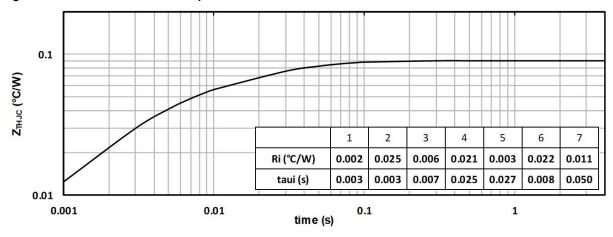


Figure 1-16. Forward Characteristics

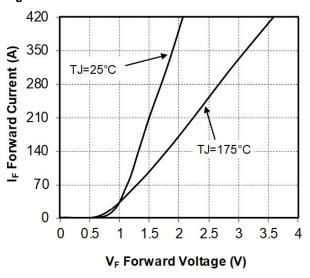
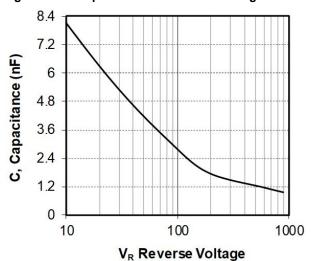


Figure 1-17. Capacitance vs. Reverse Voltage



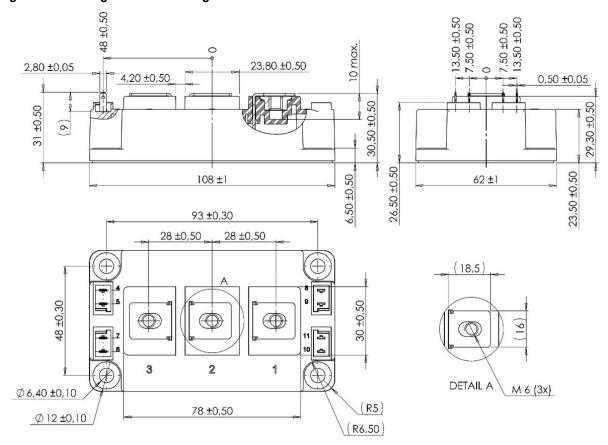
2. Package Specifications

The following section shows the package specification of the MSCSM170AM039CD3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170AM039CD3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See application note 1908—Mounting instructions for D3 and D4 power modules for more information.

3. Revision History

Revision	Date	Description
Α	04/2021	This is the first publication of this document.

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