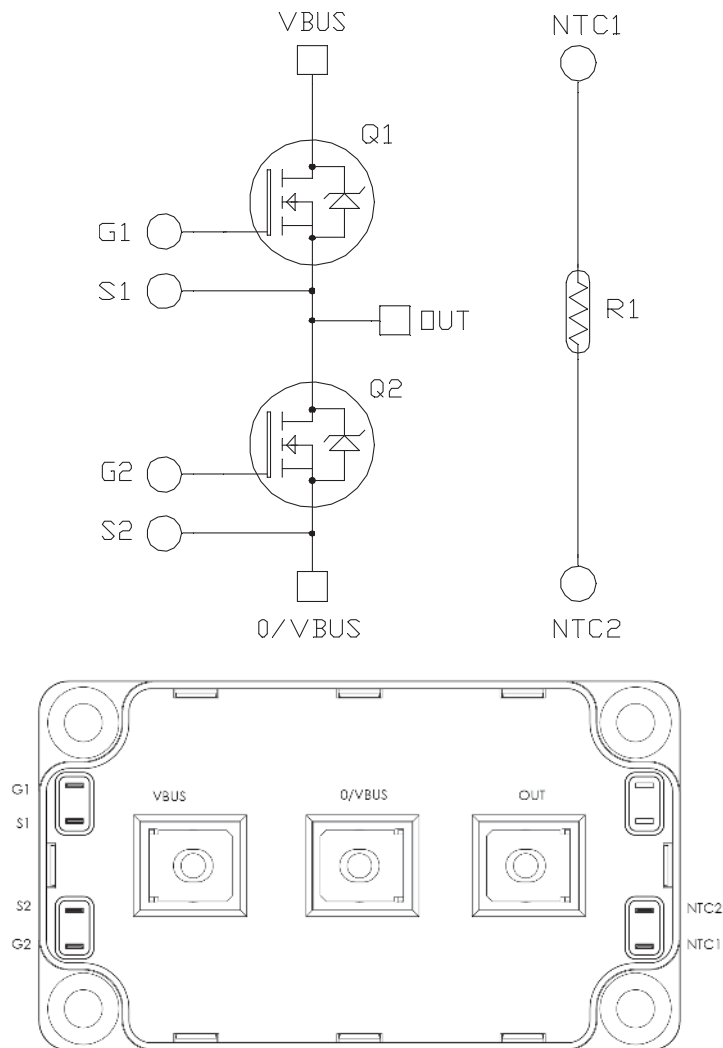


Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM120AM042T6AG device is a full bridge 1200V, 495A phase leg silicon carbide (SiC) MOSFET 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 the MSCSM120AM042T6AG device:

- SiC Power MOSFET
 - Low $R_{DS(on)}$
 - High temperature performance
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM120AM042T6AG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS compliant

Application

The MSCSM120AM042T6AG device is designed for the following applications:

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

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120AM042T6AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM042T6AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	495 ¹
		$T_C = 80\text{ }^\circ\text{C}$	395 ¹
I_{DM}	Pulsed drain current	990	
V_{GS}	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	5.2	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	2031

Note:

1. SiC MOSFET device specification, but the 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 MSCSM120AM042T6AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit	
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$	—	60	600	μA	
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 240A$	$T_J = 25\text{ }^\circ\text{C}$	—	4.2	5.2	m Ω
			$T_J = 175\text{ }^\circ\text{C}$	—	6.7	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 18\text{ mA}$	1.8	2.8	—	V	
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V; V_{DS} = 0V$	—	—	600	nA	

MSCSM120AM042T6AG

Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM042T6AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{GS} = 0V$	—	18.1	—	nF
C_{oss}	Output capacitance	$V_{DS} = 1000V$	—	1.6	—	
C_{rss}	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	0.15	—	
Q_g	Total gate charge	$V_{GS} = -5V/20V$	—	1392	—	nC
Q_{gs}	Gate-Source charge	$V_{Bus} = 800V$	—	246	—	
Q_{gd}	Gate-Drain charge	$I_D = 240A$	—	300	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^\circ\text{C}$	66	—	ns
T_r	Rise time	$V_{Bus} = 600V$		74	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 300A$		166	—	
T_f	Fall time	$R_{G(on)} = 4.7\Omega$ $R_{G(off)} = 1.8\Omega$		67	—	
E_{on}	Turn-on energy	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^\circ\text{C}$	9.5	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 600V$ $I_D = 300A$ $R_{G(on)} = 4.7\Omega$ $R_{G(off)} = 1.8\Omega$	$T_J = 150\text{ }^\circ\text{C}$	4.3	—	
R_{Gint}	Internal gate resistance		—	1	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.074	$^\circ\text{C/W}$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM042T6AG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$V_{GS} = 0V; I_{SD} = 240A$	—	4	—	V
		$V_{GS} = -5V; I_{SD} = 240A$	—	4.2	—	
t_{rr}	Reverse recovery time	$I_{SD} = 240A; V_{GS} = -5V$	—	90	—	ns
Q_{rr}	Reverse recovery charge	$V_R = 800V; di_F/dt = 6000\text{ A}/\mu\text{s}$	—	3300	—	nC
I_{rr}	Reverse recovery current		—	81	—	A

1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM042T6AG device.

Table 1-5. Thermal and Package Characteristics

Symbol	Characteristics	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	For terminals	M5	2	3.5	N.m
		To heatsink	M6	3	5	
Wt	Package weight	—	300	g		

The following table lists the temperature sensor NTC of the MSCSM120AM042T6AG device.

Table 1-6. 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	—	%

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

T: Thermistor temperature
R_T: Thermistor value at T

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

1.3 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120AM042T6AG device.

Figure 1-1. Maximum Thermal Impedance

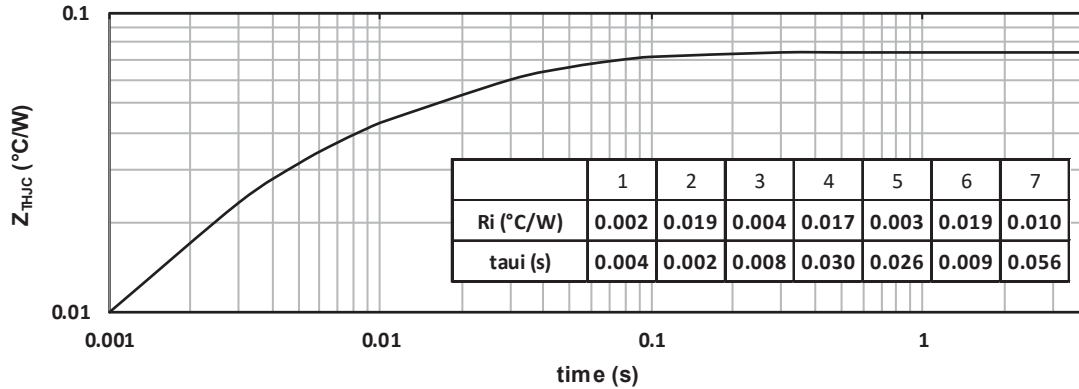


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

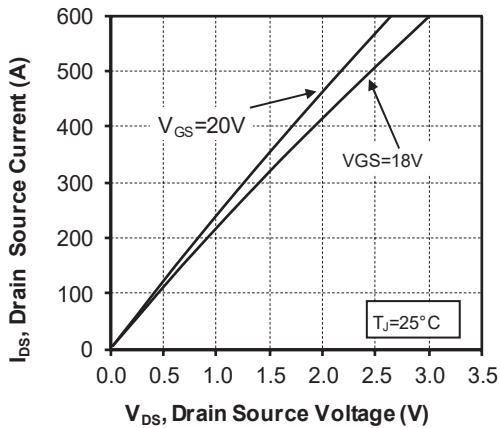


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

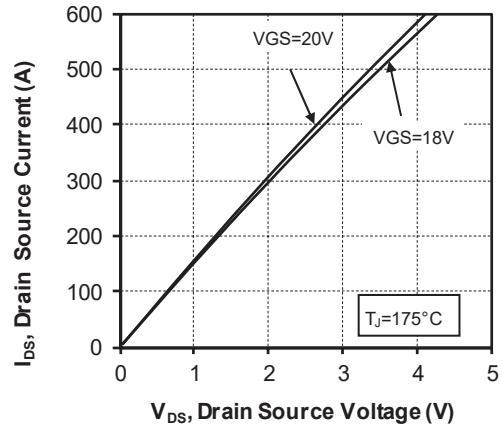


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

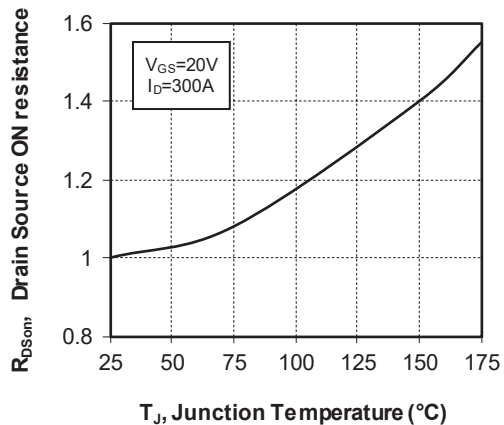


Figure 1-5. Transfer Characteristics

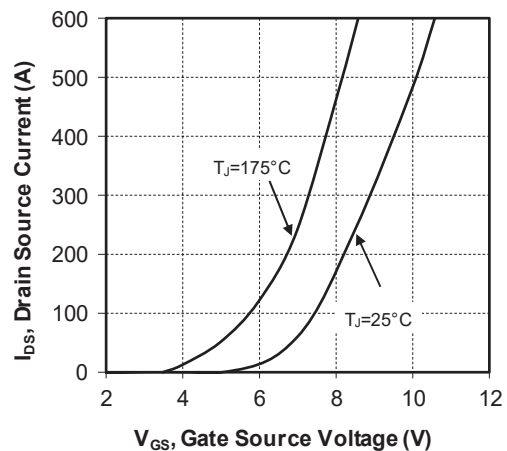


Figure 1-6. Switching Energy vs. Current

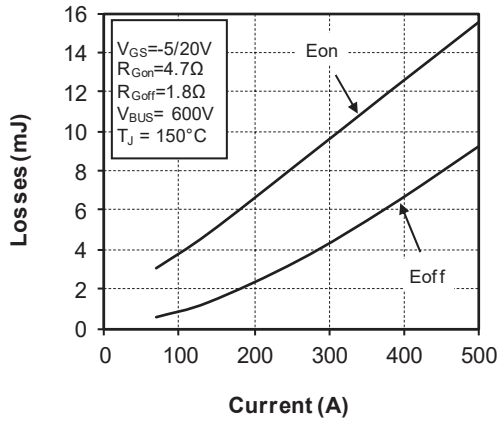


Figure 1-7. Switching Energy vs. Rg

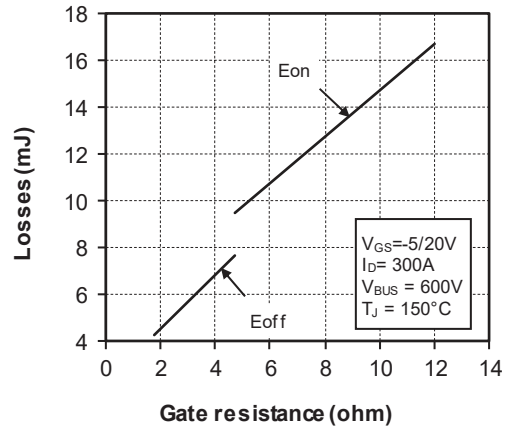


Figure 1-8. Capacitance vs. Drain Source Voltage

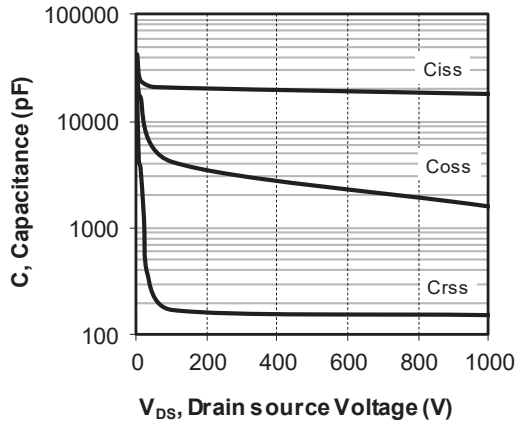


Figure 1-9. Gate Charge vs. Gate Source Voltage

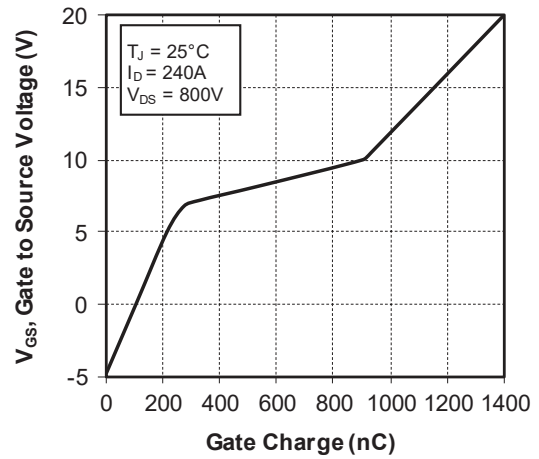


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ C$

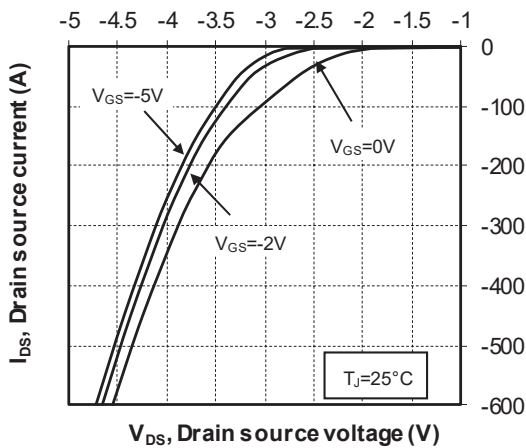


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ C$

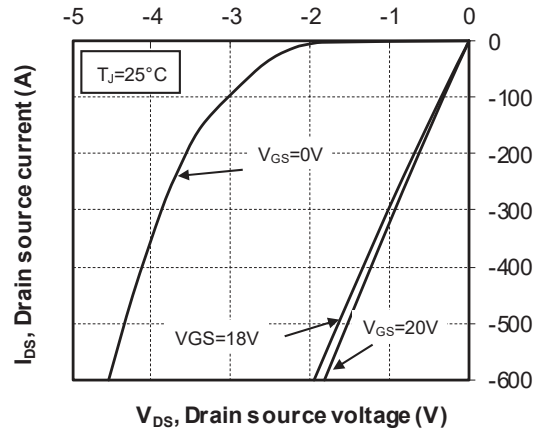


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

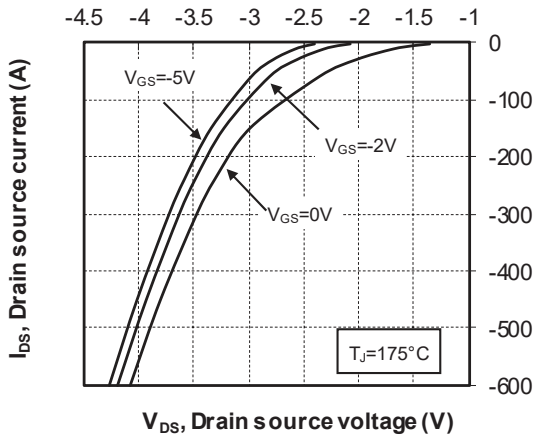


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

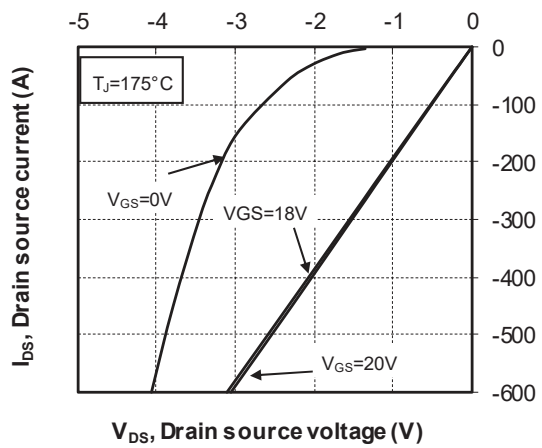
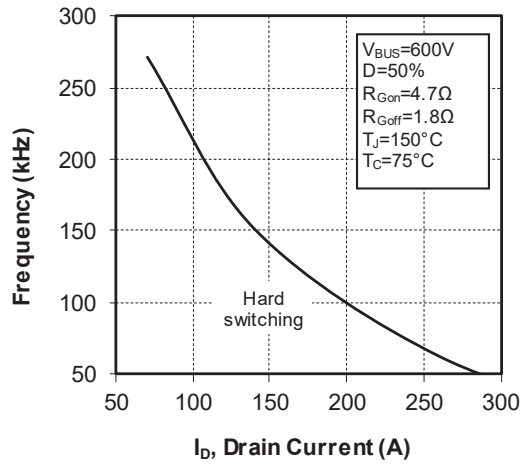


Figure 1-14. Operating Frequency vs Drain Current



3. Revision History

Revision	Date	Description
A	06/2022	Initial Revision.

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