

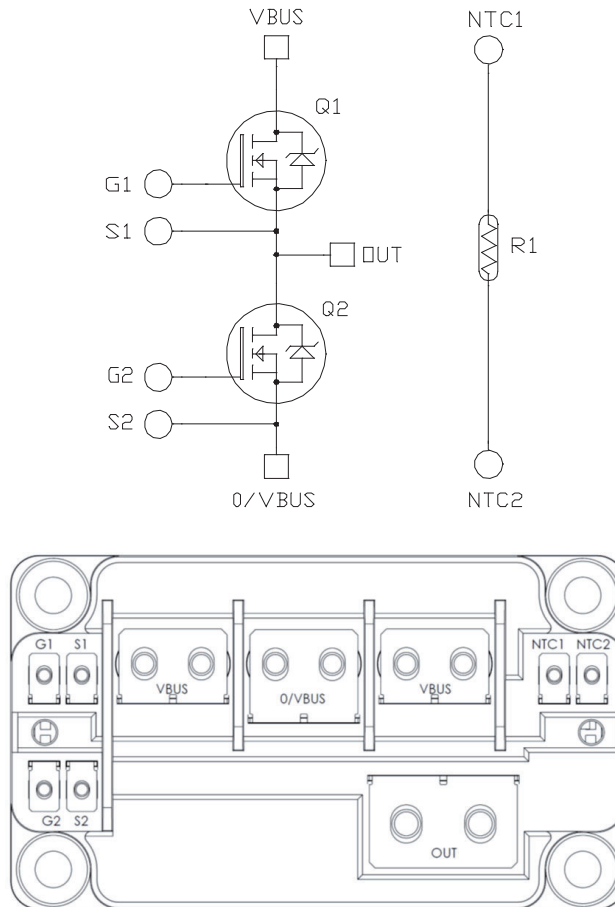


MSCSM120AM042T6LIAG

Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM120AM042T6LIAG device is a very low stray inductance phase leg 1200V, 495A silicon carbide (SiC) MOSFET power module.



Note: All ratings at $T_J = 25^\circ\text{C}$, unless otherwise specified.



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

Features

The following are key features of the MSCSM120AM042T6LIAG device:

- SiC Power MOSFET
 - Low $R_{DS(on)}$
 - High temperature performance
- M2.5 signals connectors
- Very low stray inductance
- M4 and M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM120AM042T6LIAG device:

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

Application

The MSCSM120AM042T6LIAG 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 MSCSM120AM042T6LIAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM042T6LIAG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DS}	Drain-Source voltage		1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	495 ¹	A
		$T_C = 80\text{ }^{\circ}\text{C}$	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	W

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 MSCSM120AM042T6LIAG 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	$V_{GS} = 20V$ $I_D = 240A$	—	4.2	5.2	m Ω
		$T_J = 175^{\circ}\text{C}$	—	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	$V_{GS} = 20V$; $V_{DS} = 0V$	—	—	0.6	μA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM042T6LIAG 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	$T_J = 150\text{ }^{\circ}C$	—	56	—	ns
T_r	Rise time	$V_{GS} = -5V/20V$	—	55	—	
$T_{d(off)}$	Turn-off delay time	$V_{Bus} = 600V$	—	166	—	
T_f	Fall time	$I_D = 300A$ $R_G = 1\Omega$	—	67	—	
E_{on}	Turn-on energy	$V_{GS} = -5V/20V$ $T_J = 150\text{ }^{\circ}C$	—	7.3	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 600V$ $I_D = 300A$ $R_G = 1\Omega$ $T_J = 150\text{ }^{\circ}C$	—	5.6	—	
R_{Gint}	Internal gate resistance		—	1.6	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.074	$^{\circ}C/W$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM042T6LIAG 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	$V_R = 800V$; $di_F/dt = 6000\text{ A}/\mu s$	—	3.3	—	μC
I_{rr}	Reverse recovery current		—	81	—	A

1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM042T6LIAG 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	M2.5	0.4	0.6	N.m
			M4	2	3	
			M5	2	3.5	
		To heatsink	M6	3	5	
L _{DC}	Module stray inductance between VBUS and 0/VBUS			—	3	nH
Wt	Package weight			—	320	g

The following table lists the temperature sensor NTC of the MSCSM120AM042T6LIAG 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 = 298.15 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.

1.3 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120AM042T6LIAG device.

Figure 1-1. Maximum Thermal Impedance

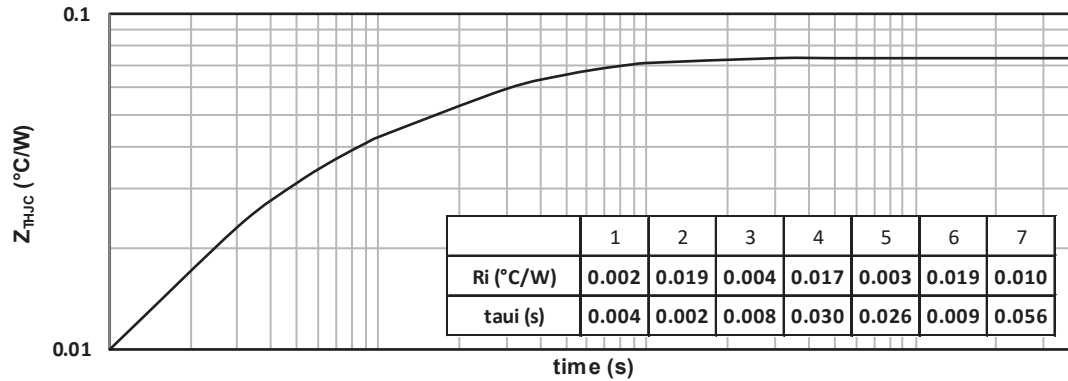


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

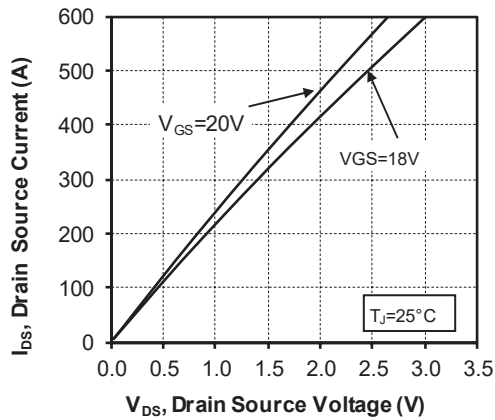


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

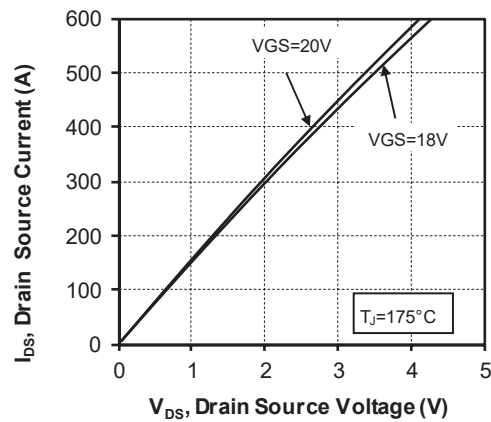


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

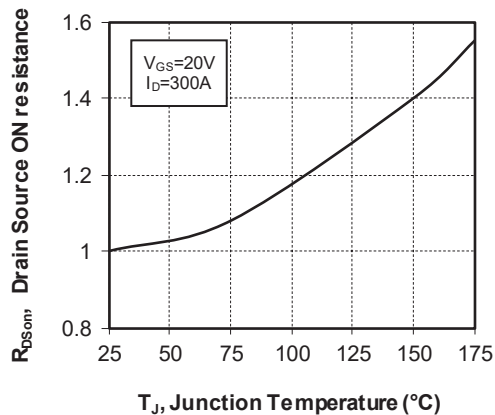


Figure 1-5. Transfer Characteristics

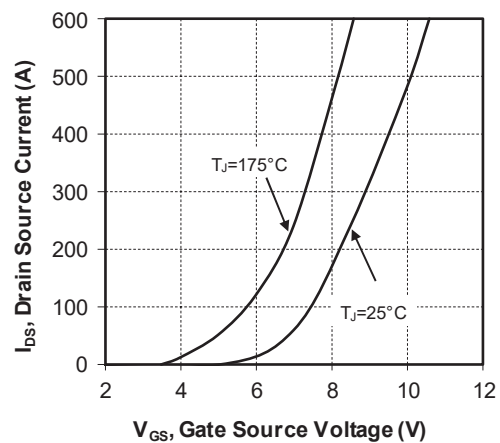


Figure 1-6. Switching Energy vs. Current

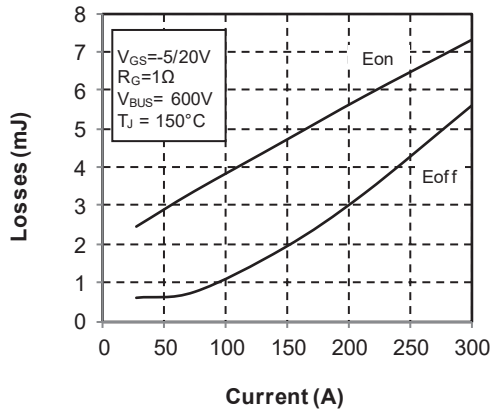


Figure 1-7. Turn On Energy vs. Rg

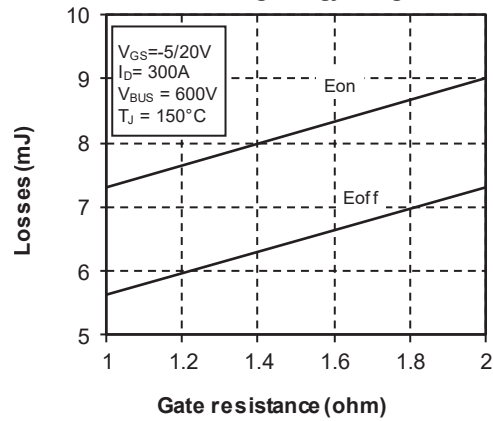


Figure 1-8. Capacitance vs. Drain Source Voltage

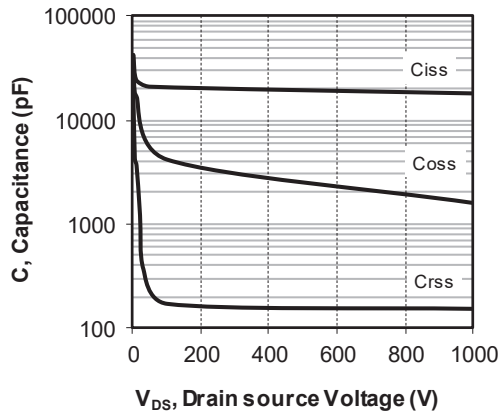
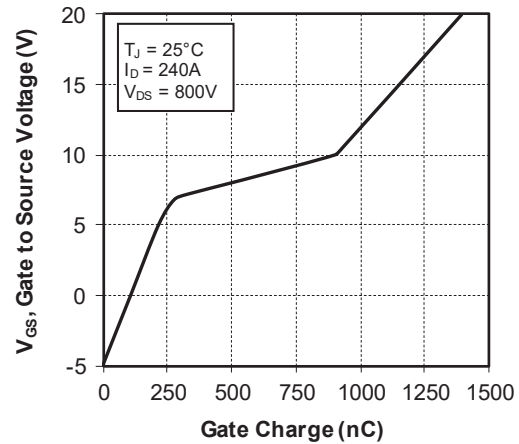


Figure 1-9. Gate Charge vs. Gate Source Voltage



3rd Quadrant Characteristics

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

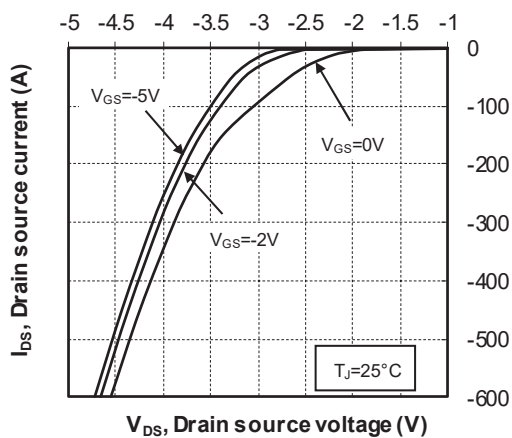


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

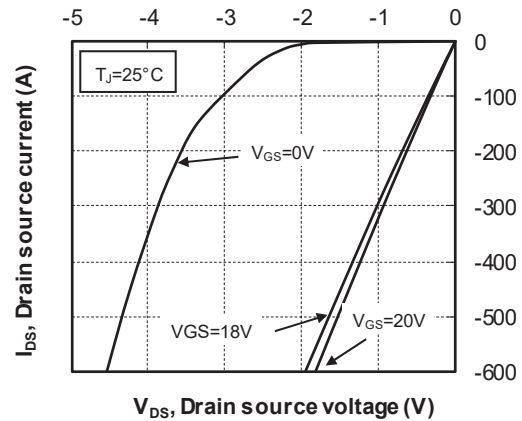


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

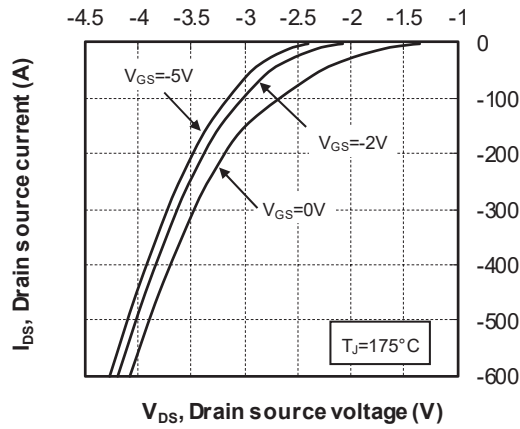


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

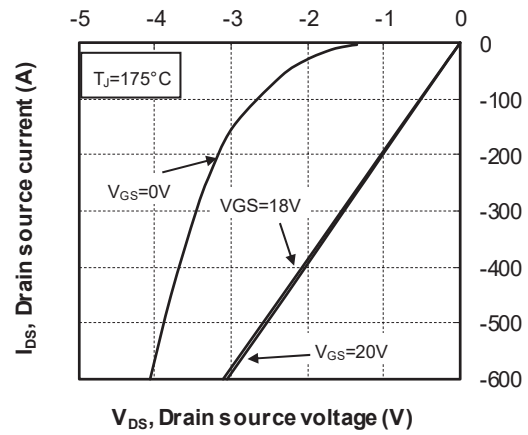
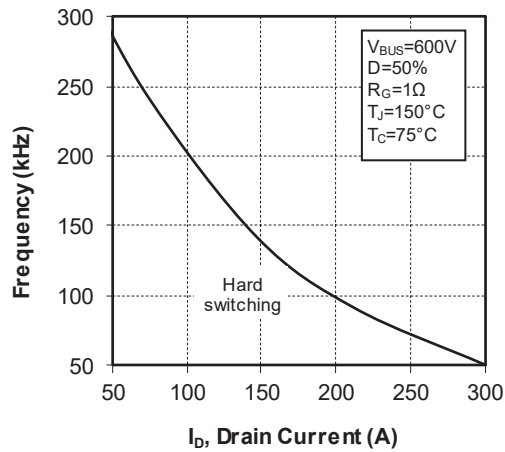


Figure 1-14. Operating Frequency vs Drain Current



The following section shows the package specification of the MSCSM120AM042T6LIAG device.

The following figure shows the package outline drawing of the MSCSM120AM042T6LIAG device. The dimensions in the following figure are in millimeters.

Technical drawing of the 1000mm x 1000mm x 16mm base plate, showing three views: top, front, and side.

Top View Dimensions:

- Overall width: 1080mm
- Overall height: 220mm
- Central cutout width: 93mm
- Central cutout height: 108mm
- Distance from top edge to first row of screws: 17mm
- Distance from bottom edge to first row of screws: 17mm
- Distance from left edge to first row of screws: 10mm
- Distance from right edge to first row of screws: 10mm
- Distance between rows of screws: 20mm, 10mm, 2mm, 15mm, 10mm
- Distance from center to first row of screws: 54mm
- Distance from center to second row of screws: 54mm
- Distance from center to third row of screws: 54mm
- Distance from center to fourth row of screws: 54mm
- Distance from center to fifth row of screws: 54mm
- Distance from center to sixth row of screws: 54mm
- Distance from center to seventh row of screws: 54mm
- Distance from center to eighth row of screws: 54mm
- Distance from center to ninth row of screws: 54mm
- Distance from center to tenth row of screws: 54mm
- Distance from center to eleventh row of screws: 54mm
- Distance from center to twelfth row of screws: 54mm

Front View Dimensions:

- Overall width: 1080mm
- Overall height: 220mm
- Central cutout width: 93mm
- Central cutout height: 108mm
- Distance from top edge to first row of screws: 17mm
- Distance from bottom edge to first row of screws: 17mm
- Distance from left edge to first row of screws: 10mm
- Distance from right edge to first row of screws: 10mm
- Distance between rows of screws: 20mm, 10mm, 2mm, 15mm, 10mm
- Distance from center to first row of screws: 54mm
- Distance from center to second row of screws: 54mm
- Distance from center to third row of screws: 54mm
- Distance from center to fourth row of screws: 54mm
- Distance from center to fifth row of screws: 54mm
- Distance from center to sixth row of screws: 54mm
- Distance from center to seventh row of screws: 54mm
- Distance from center to eighth row of screws: 54mm
- Distance from center to ninth row of screws: 54mm
- Distance from center to tenth row of screws: 54mm
- Distance from center to eleventh row of screws: 54mm
- Distance from center to twelfth row of screws: 54mm

Side View Dimensions:

- Overall width: 1080mm
- Overall height: 220mm
- Central cutout width: 93mm
- Central cutout height: 108mm
- Distance from top edge to first row of screws: 17mm
- Distance from bottom edge to first row of screws: 17mm
- Distance from left edge to first row of screws: 10mm
- Distance from right edge to first row of screws: 10mm
- Distance between rows of screws: 20mm, 10mm, 2mm, 15mm, 10mm
- Distance from center to first row of screws: 54mm
- Distance from center to second row of screws: 54mm
- Distance from center to third row of screws: 54mm
- Distance from center to fourth row of screws: 54mm
- Distance from center to fifth row of screws: 54mm
- Distance from center to sixth row of screws: 54mm
- Distance from center to seventh row of screws: 54mm
- Distance from center to eighth row of screws: 54mm
- Distance from center to ninth row of screws: 54mm
- Distance from center to tenth row of screws: 54mm
- Distance from center to eleventh row of screws: 54mm
- Distance from center to twelfth row of screws: 54mm

Note: See [AN1911 - Mounting instructions for SP6 Low inductance Power Module](#) for more information.

3. Revision History

Revision	Date	Description
A	06/2021	Initial Revision.

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