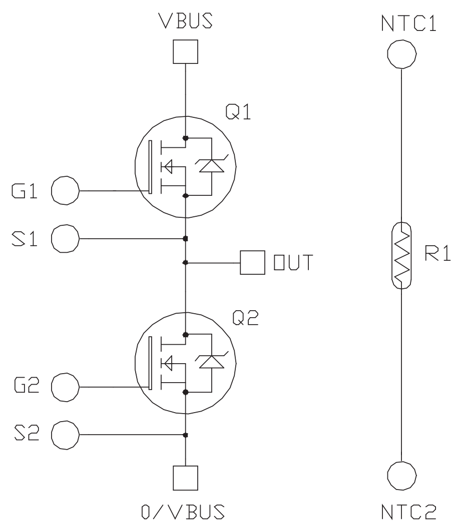
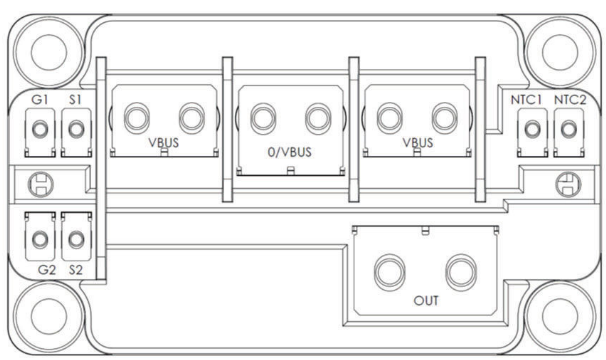
MSCSM120AM03T6LIAG

Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM120AM03T6LIAG device is a very low stray inductance phase leg 1200V, 805A silicon carbide (SiC) MOSFET power module.





Note: 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 key features of the MSCSM120AM03T6LIAG 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 MSCSM120AM03T6LIAG 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 MSCSM120AM03T6LIAG 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 MSCSM120AM03T6LIAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM03T6LIAG 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 °C	805[1]	A
		T_C = 80 °C	640[1]	
I_{DM}	Pulsed drain current		1600	
V_{GS}	Gate-Source voltage		–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		3.1	mΩ
P_D	Power dissipation	T_C = 25 °C	3215	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 MSCSM120AM03T6LIAG 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		—	150	1000	µA
$R_{DS(on)}$	Drain–Source on resistance	V_{GS} = 20V	T_J = 25 °C	—	2.5	3.1	mΩ
		I_D = 400A	T_J = 175 °C	—	4	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ I_D = 30 mA		1.8	2.8	—	V
I_{GSS}	Gate–Source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	1	µA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM03T6LIAG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0V V_{DS} = 1000V f = 1 MHz		—	30.2	—	nF
C_{oss}	Output capacitance			—	2.7	—	
C_{rss}	Reverse transfer capacitance			—	0.25	—	
Q_g	Total gate charge	V_{GS} = –5V/20V V_{Bus} = 800V I_D = 400A		—	2320	—	nC
Q_{gs}	Gate-Source charge			—	410	—	
Q_{gd}	Gate-Drain charge			—	500	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V V_{Bus} = 600V I_D = 500A R_G = 0.6Ω	T_J = 150 °C	—	56	—	ns
T_r	Rise time			—	55	—	
$T_{d(off)}$	Turn-off delay time			—	166	—	
T_f	Fall time			—	67	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V V_{Bus} = 600V I_D = 500A R_G = 0.6Ω	T_J = 150 °C	—	12.2	—	mJ
E_{off}	Turn-off energy			—	9.4	—	
R_{Gint}	Internal gate resistance			—	0.98	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.047	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM03T6LIAG 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} = 400A	—	4	—	V
		V_{GS} = –5V; I_{SD} = 400A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 400A; V_{GS} = –5V V_R = 800V; di_F/dt = 10000 A/µs	—	90	—	ns
Q_{rr}	Reverse recovery charge		—	5.5	—	µC
I_{rr}	Reverse recovery current		—	135	—	A

1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM03T6LIAG 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 MSCSM120AM03T6LIAG 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	—	%

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

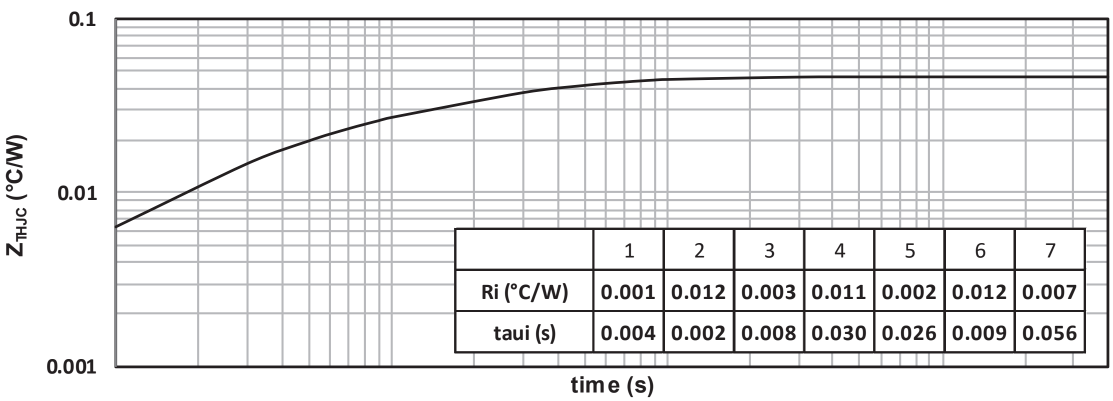
T: Thermistor temperature
R_T: Thermistor value at T

Note: 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 MSCSM120AM03T6LIAG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	**0.001**	**0.012**	**0.003**	**0.011**	**0.002**	**0.012**	**0.007**
taui (s)	**0.004**	**0.002**	**0.008**	**0.030**	**0.026**	**0.009**	**0.056**

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

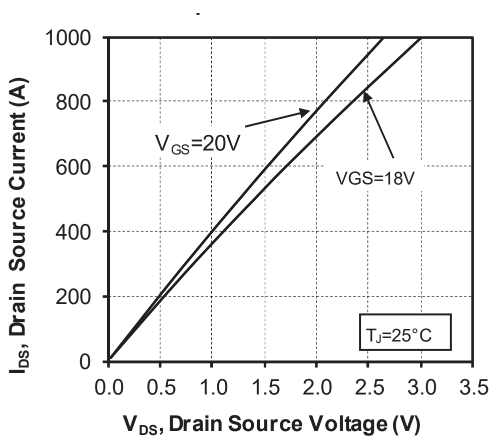


Figure 1-3. Output Characteristics, T_J = 175 °C

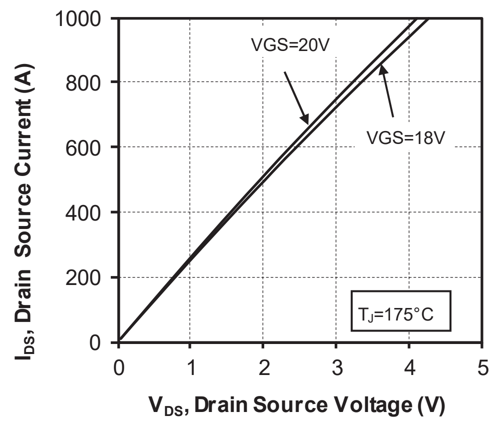


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

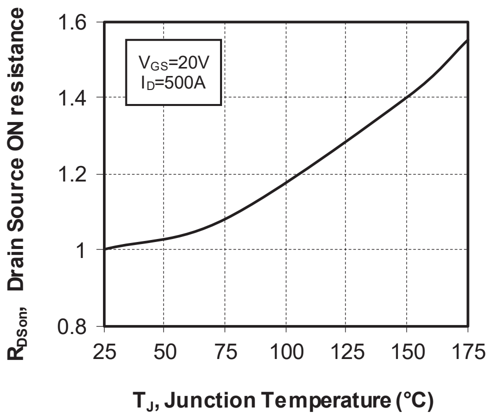


Figure 1-5. Transfer Characteristics

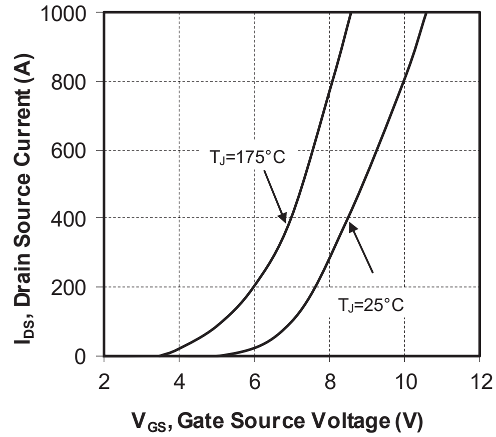


Figure 1-6. Switching Energy vs. Current

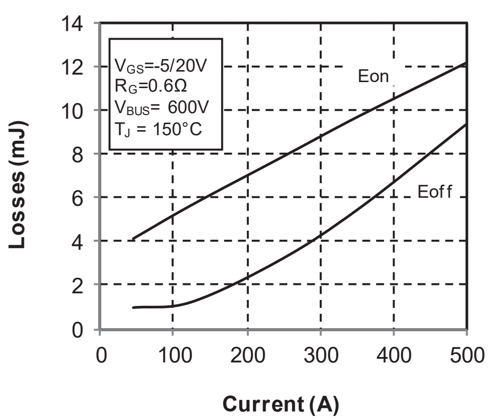


Figure 1-7. Switching Energy vs. Rg

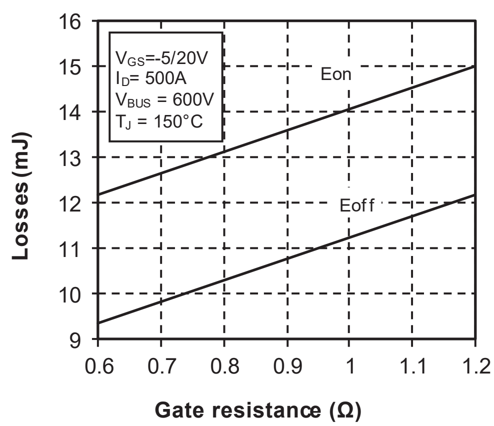


Figure 1-8. Capacitance vs. Drain Source Voltage

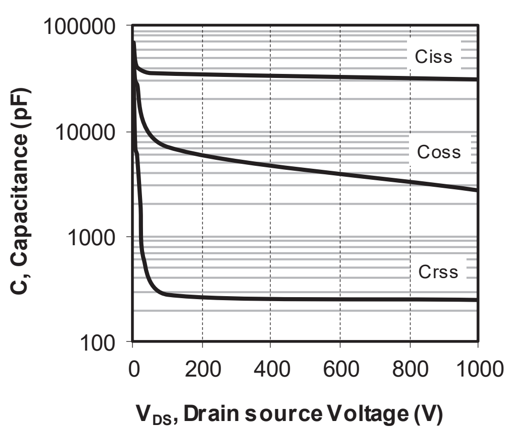


Figure 1-9. Gate Charge vs. Gate Source Voltage

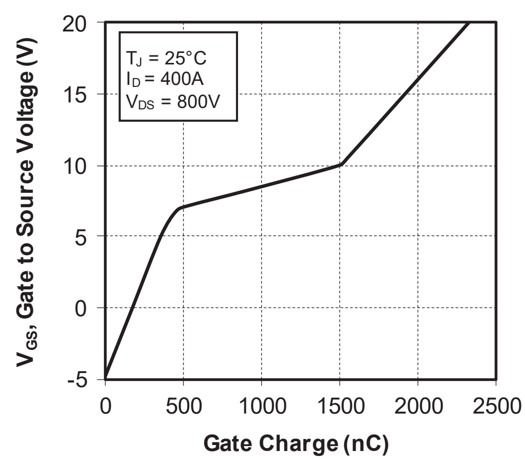


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

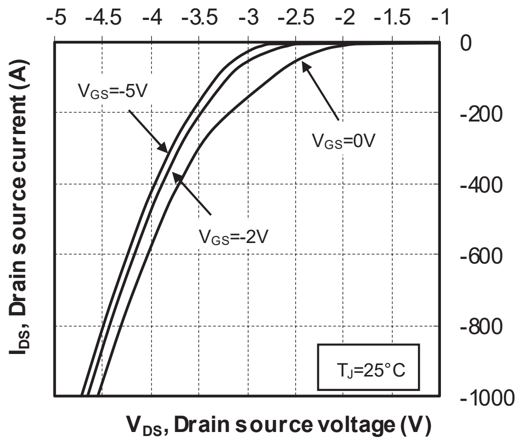


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

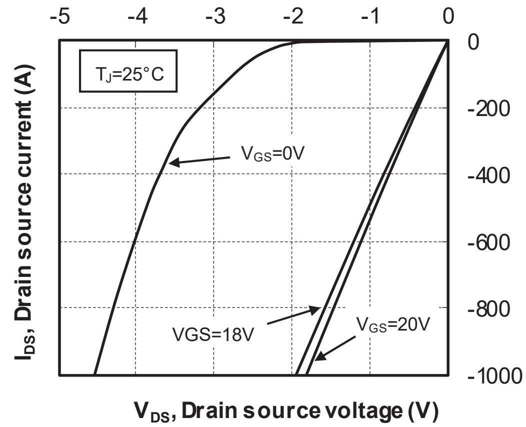


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

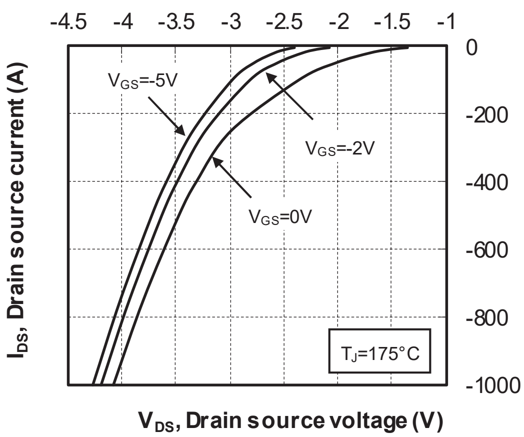


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

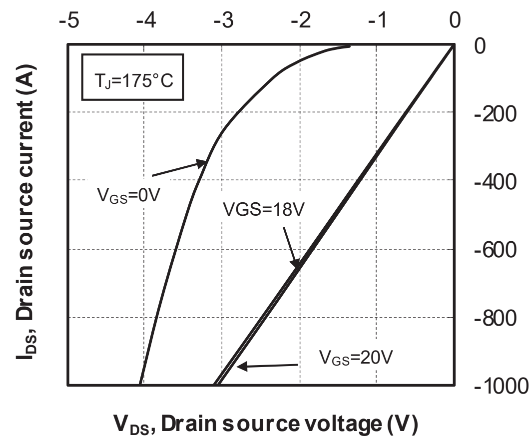
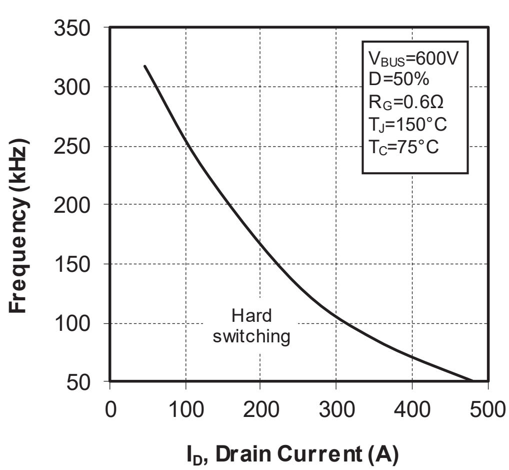


Figure 1-14. Operating Frequency vs Drain Current



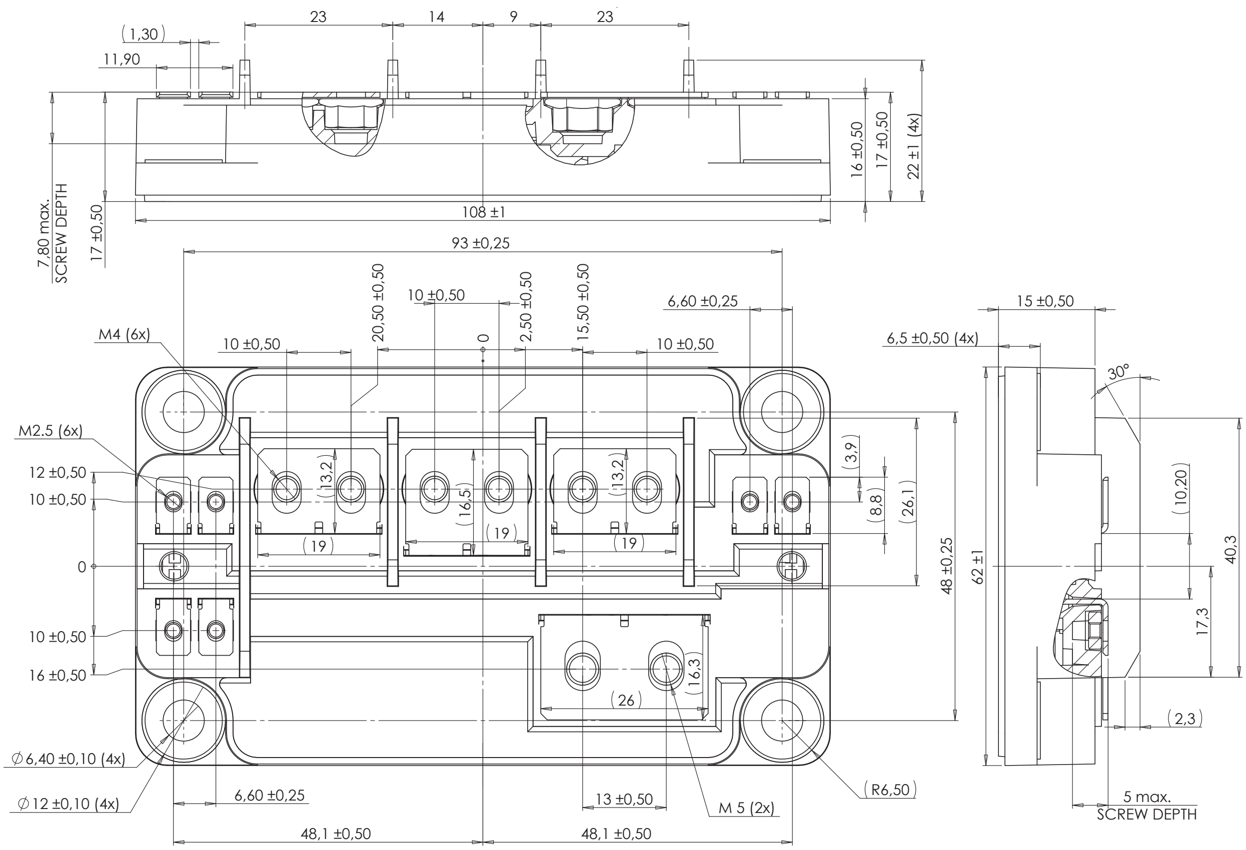
2. Package Specifications

The following section shows the package specification of the MSCSM120AM03T6LIAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120AM03T6LIAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See AN1911 - Mounting instructions for SP6 Low inductance Power Module for more information.

3. Revision History

Revision	Date	Description
A	06/2022	Initial Revision

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