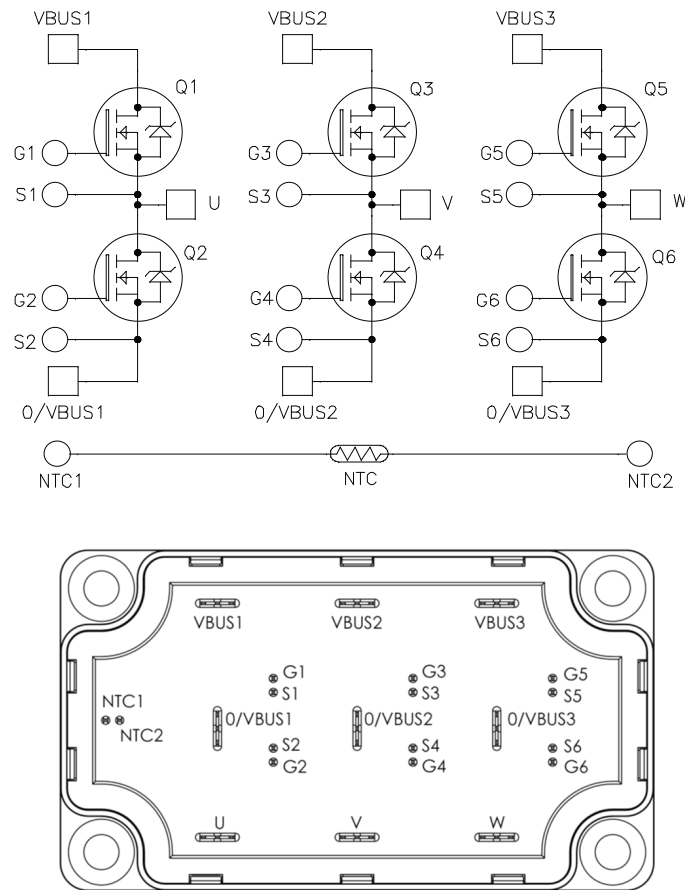


Triple Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM120TAM11TPAG device is a triple phase leg 1200V, 251A silicon carbide (SiC) 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 the key features of the MSCSM120TAM11TPAG device:

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

Benefits

The following are the benefits of the MSCSM120TAM11TPAG device:

- High power and efficiency converters and inverters
- 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 following are the applications of the MSCSM120TAM11TPAG device:

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

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120TAM11TPAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of the MSCSM120TAM11TPAG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$ 251 ¹	A
		$T_C = 80\text{ }^{\circ}\text{C}$ 200 ¹	
I_{DM}	Pulsed drain current	500	
V_{GS}	Gate-Source voltage	–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	10.4	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$ 1042	W

Note:

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

The following table lists the electrical characteristics of the MSCSM120TAM11TPAG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$	—	30	300	μA
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 120A$ $T_J = 25\text{ }^{\circ}\text{C}$	—	8.4	10.4	m Ω
		$T_J = 175\text{ }^{\circ}\text{C}$	—	13.4	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 9\text{ mA}$	1.8	2.8	—	V
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V$ $V_{DS} = 0V$	—	—	300	nA

MSCSM120TAM11TPAG

Electrical Specifications

The following table lists the dynamic characteristics of the MSCSM120TAM11TPAG device.

Table 1-3. Dynamic Characteristics

Symb ol	Characteristics	Test Conditions	Min.	Typ.	Max.	Unit	
C _{iss}	Input capacitance	V _{GS} = 0V	—	9060	—	pF	
C _{oss}	Output capacitance	V _{DS} = 1000V f = 1 MHz	—	810	—		
C _{rss}	Reverse transfer capacitance		—	75	—		
Q _g	Total gate charge	V _{GS} = −5V/20V	—	696	—	nC	
Q _{gs}	Gate-source charge	V _{BUS} = 800V I _D = 120A	—	123	—		
Q _{gd}	Gate-drain charge		—	150	—		
T _{d(on)}	Turn-on delay time	V _{GS} = −5V/20V	—	30	—	ns	
T _r	Rise time	V _{BUS} = 600V	—	30	—		
T _{d(off)}	Turn-off delay time	I _D = 150A	—	50	—		
T _f	Fall time	R _{GON} = 2.7Ω R _{GOFF} = 1.6Ω		25	—		
E _{on}	Turn-on energy	V _{GS} = −5V/20V	T _J = 150 °C	—	3.6	—	mJ
E _{off}	Turn-off energy	V _{BUS} = 600V I _D = 150A R _{GON} = 2.7Ω R _{GOFF} = 1.6Ω		—	2	—	mJ
R _{Gint}	Internal gate resistance		—	2	—	Ω	
R _{thJC}	Junction-to-case thermal resistance		—	—	0.144	°C/W	

The following table lists the body diode ratings and characteristics of the MSCSM120TAM11TPAG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$V_{GS} = 0V$ $I_{SD} = 120A$	—	4	—	V
		$V_{GS} = -5V$ $I_{SD} = 120A$	—	4.2	—	
t_{rr}	Reverse recovery time	$I_{SD} = 120A$	—	90	—	ns
Q_{rr}	Reverse recovery charge	$V_{GS} = -5V$	—	1650	—	nC
I_{rr}	Reverse recovery current	$V_R = 800V$ $di_F/dt = 3000\text{ A}/\mu s$	—	40.5	—	A

1.2 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM120TAM11TPAG device.

Table 1-5. Thermal and Package Characteristics

Symbol	Characteristic			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	To heatsink	M6	3	5	N.m
Wt	Package weight			—	250	g

The following table lists the temperature sensor NTC of the MSCSM120TAM11TPAG 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

The following figures show the SiC MOSFET performance curves of the MSCSM120TAM11TPAG device.

Figure 1-1. Maximum Thermal Impedance

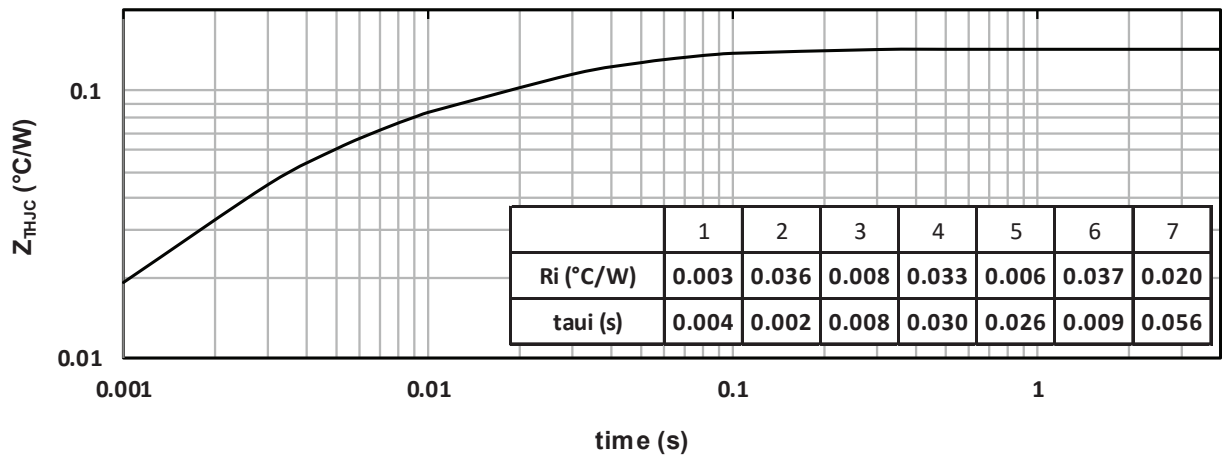


Figure 1-2. Output Characteristics, T_J = 25 °C

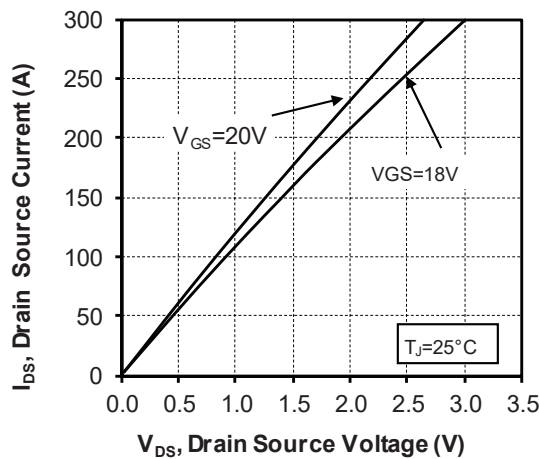


Figure 1-3. Output Characteristics, T_J = 175 °C

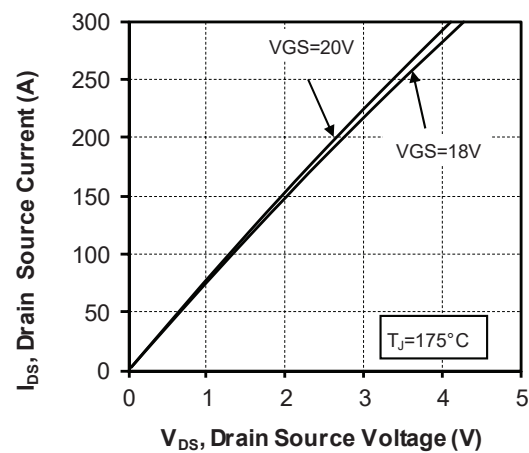


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

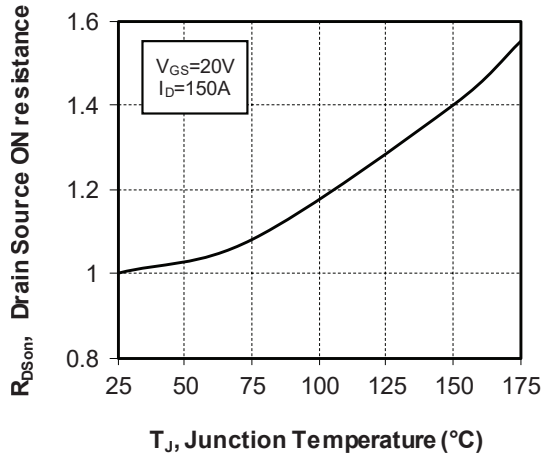


Figure 1-5. Transfer Characteristics

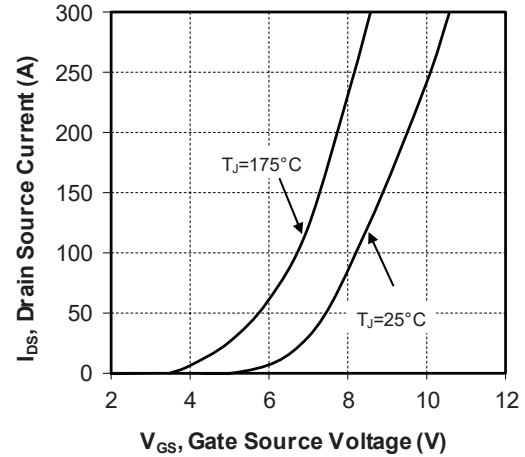


Figure 1-6. Switching Energy vs. R_g

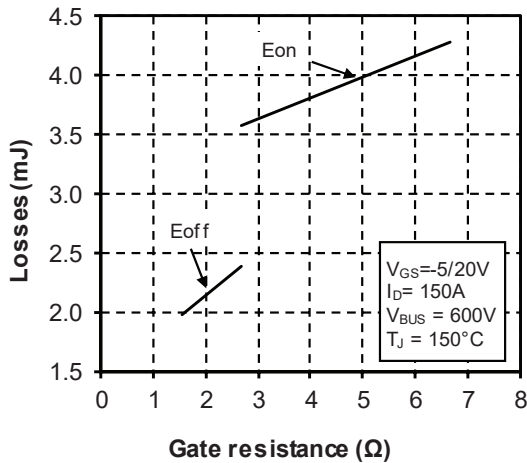


Figure 1-7. Switching Energy vs. Current

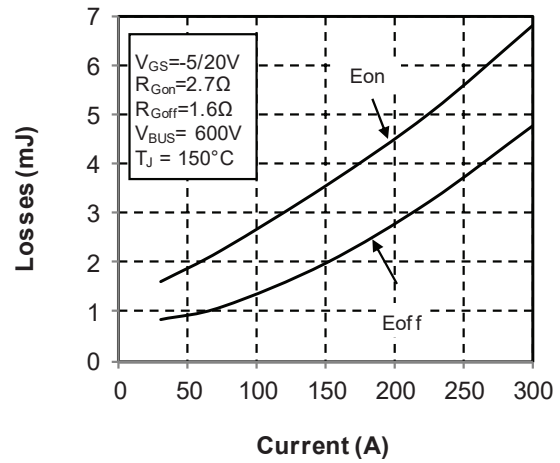


Figure 1-8. Capacitance vs. Drain Source Voltage

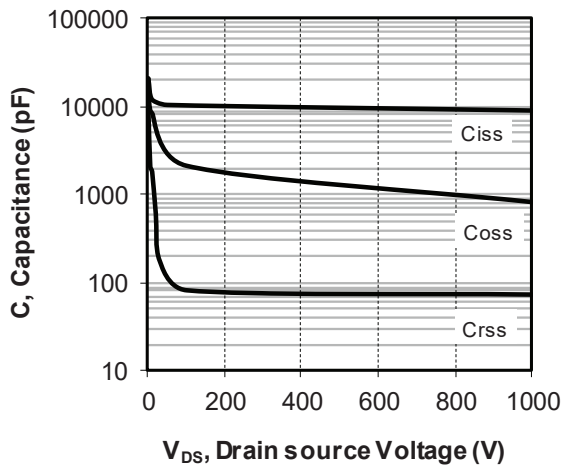
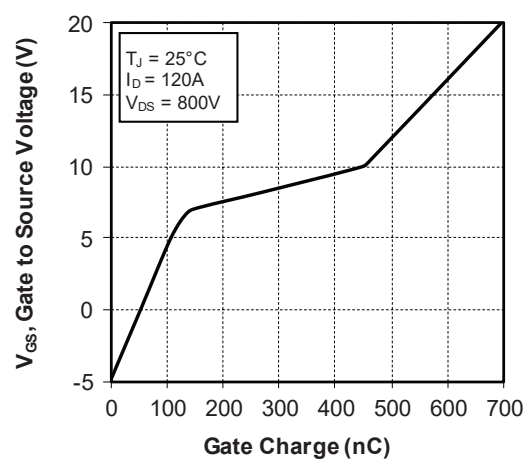


Figure 1-9. Gate Charge vs. Gate Source Voltage



MSCSM120TAM11TPAG

Electrical Specifications

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

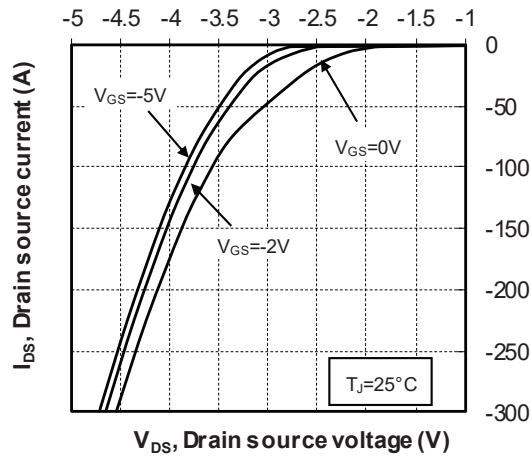


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

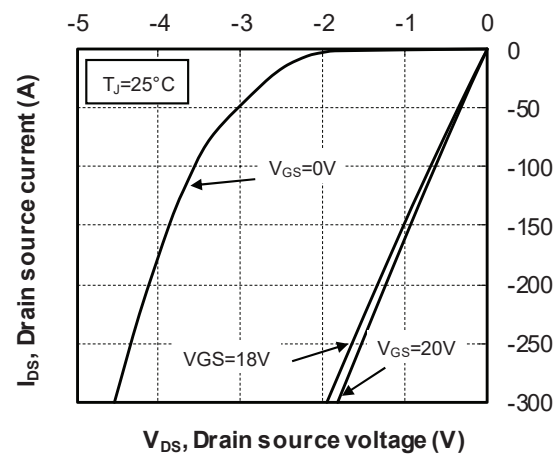


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

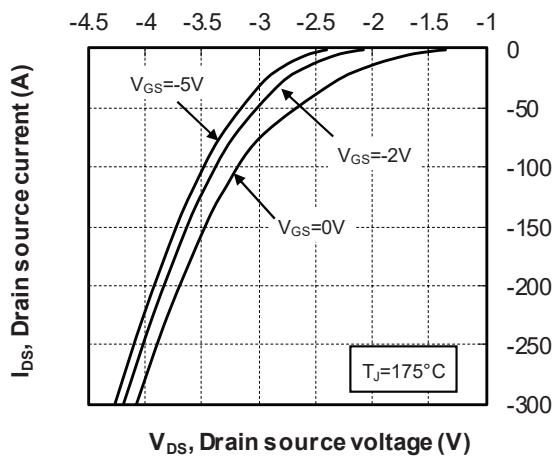


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

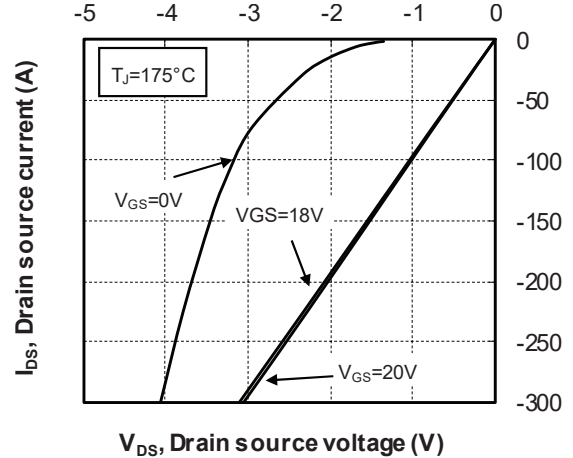
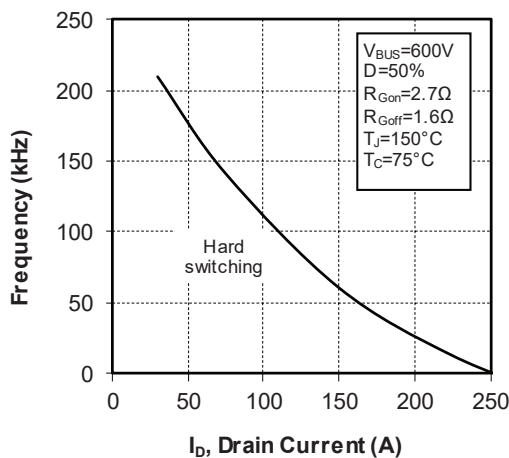


Figure 1-14. Operating Frequency vs. Drain Current



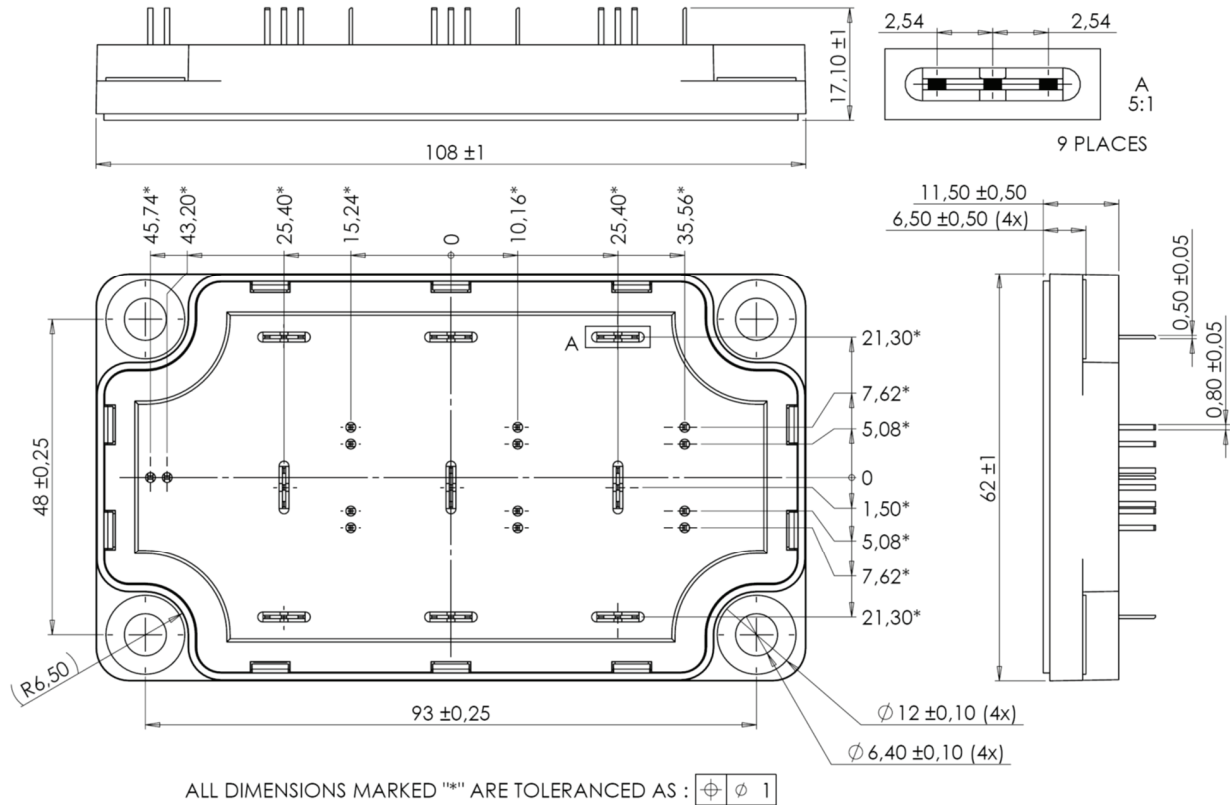
2. Package Specifications

The following section shows the package specification of the MSCSM120TAM11TPAG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120TAM11TPAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See [AN1902—Mounting Instructions for SP6-P \(12 mm\) Power Modules](#) for more information.

3. Revision History

Revision	Date	Description
A	06/2022	Initial Revision

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