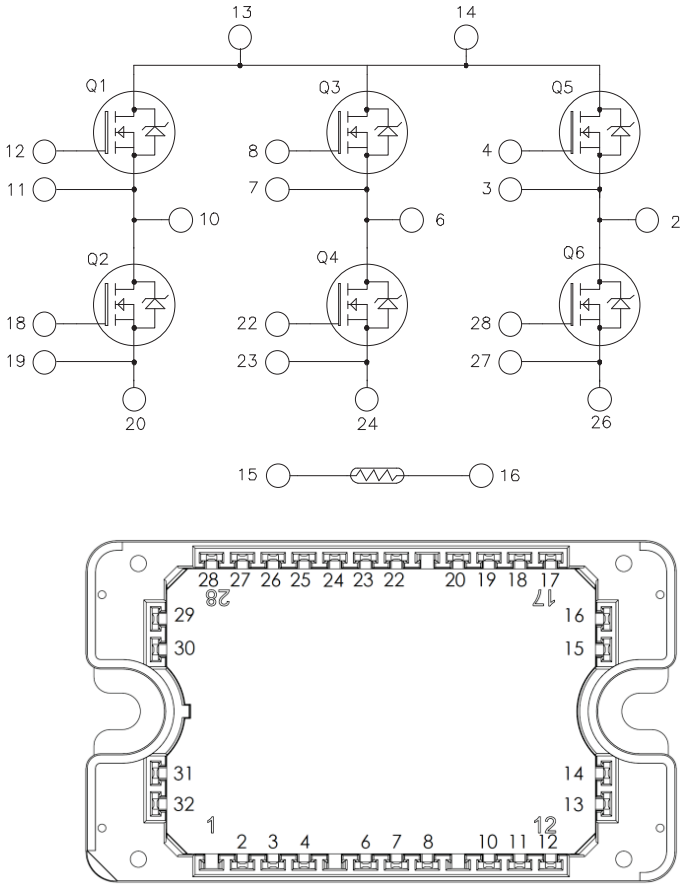
MSCSM120TAM31T3AG

Three Phase Bridge SiC MOSFET Power Module

Product Overview

The MSCSM120TAM31T3AG device is a three phase bridge 1200V, 89A silicon carbide (SiC) power module.



Notes:

- All ratings at T_J = 25 °C, unless otherwise specified.
- Pin 20, pin 24, and pin 26 must be shorted together to perform a three phase bridge.

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

Features

The following are the key features of the MSCSM120TAM31T3AG device:

- SiC Power MOSFET
  - High speed switching
  - Low $R_{DS(on)}$
  - Ultra low loss
- 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 MSCSM120TAM31T3AG device:

- High efficiency converter
- 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 MSCSM120TAM31T3AG 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 MSCSM120TAM31T3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of the MSCSM120TAM31T3AG 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	89	A
		T_C = 80 °C	71	
I_{DM}	Pulsed drain current		180	
V_{GS}	Gate-Source voltage		–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		31	mΩ
P_D	Power dissipation	T_C = 25 °C	395	W

The following table lists the electrical characteristics of the MSCSM120TAM31T3AG 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		—	10	100	µA
$R_{DS(on)}$	Drain-Source on resistance	V_{GS} = 20V I_D = 40A	T_J = 25 °C	—	25	31	mΩ
			T_J = 175 °C	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS} I_D = 3 mA		1.8	2.8	—	V
I_{GSS}	Gate-Source leakage current	V_{GS} = 20V V_{DS} = 0V		—	—	150	nA

The following table lists the dynamic characteristics of the MSCSM120TAM31T3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	3020	—	pF
C_{oss}	Output capacitance	V_{DS} = 1000V		—	270	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	25	—	
Q_g	Total gate charge	V_{GS} = –5V/20V		—	232	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 800V		—	41	—	
Q_{gd}	Gate-drain charge	I_D = 40A		—	50	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V		—	30	—	ns
T_r	Rise time	V_{Bus} = 800V		—	30	—	
$T_{d(off)}$	Turn-off delay time	I_D = 50A		—	50	—	
T_f	Fall time	R_{GON} = 8Ω R_{GOFF} = 4.7Ω			25	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V	T_J = 150 °C	—	1.2	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 600V I_D = 50A R_{GON} = 8Ω R_{GOFF} = 4.7Ω		—	0.66	—	mJ
R_{Gint}	Internal gate resistance			—	0.88	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.38	°C/W

The following table lists the body diode ratings and characteristics of the MSCSM120TAM31T3AG 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} = 40A	—	4	—	V
		V_{GS} = –5V I_{SD} = 40A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 40A	—	90	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5V	—	550	—	nC
I_{rr}	Reverse recovery current	V_R = 800V di_F/dt = 1000 A/µs	—	13.5	—	A

1.2 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM120TAM31T3AG 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	M4	2	3	N.m
Wt	Package weight			—	110	g

The following table lists the temperature sensor NTC of the MSCSM120TAM31T3AG 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} = 298.15 K	—	—	3952	—	K
ΔB/B	—	T_C = 100 °C	—	4	—	%

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

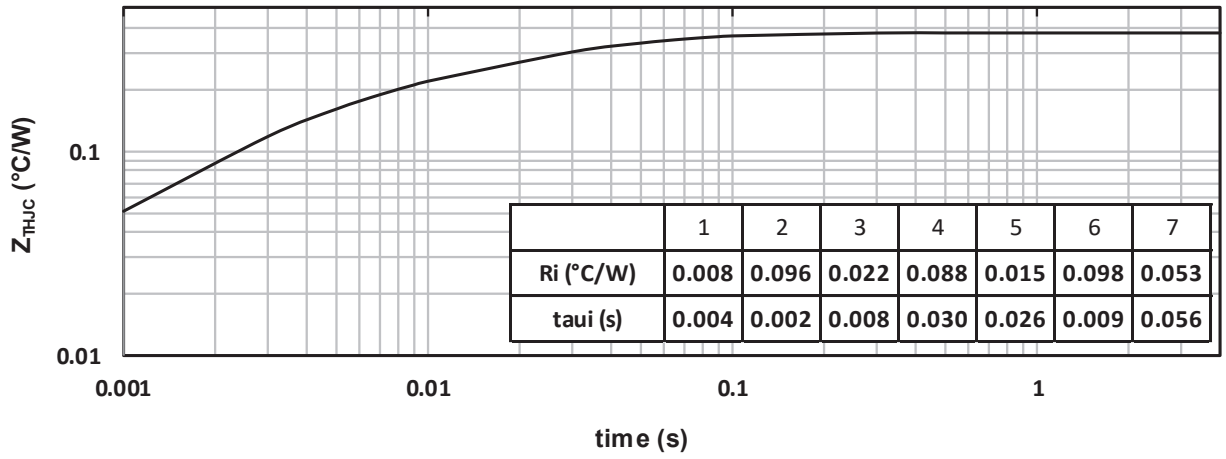
T: Thermistor temperature
R_T: Thermistor value at T

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 MSCSM120TAM31T3AG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.008	0.096	0.022	0.088	0.015	0.098	0.053
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

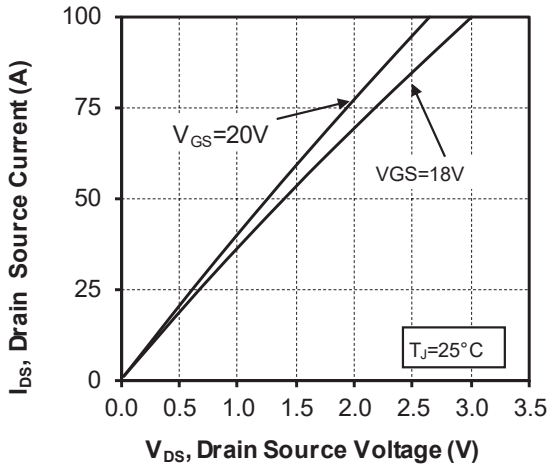


Figure 1-3. Output Characteristics, T_J = 175 °C

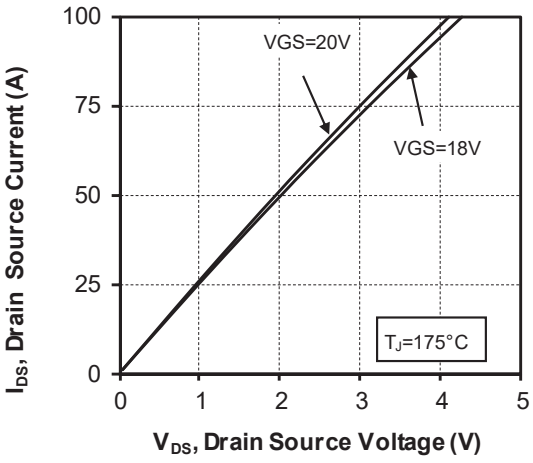


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

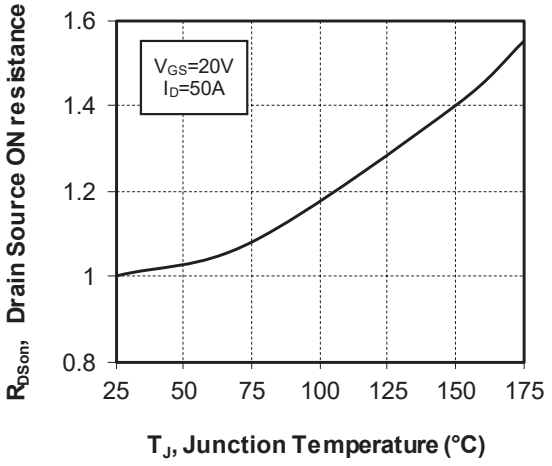


Figure 1-5. Transfer Characteristics

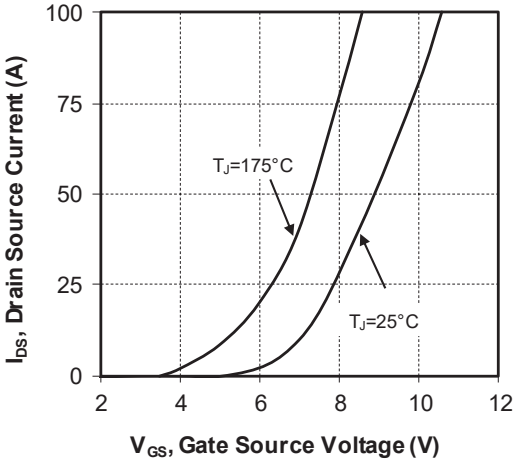


Figure 1-6. Switching Energy vs. Rg

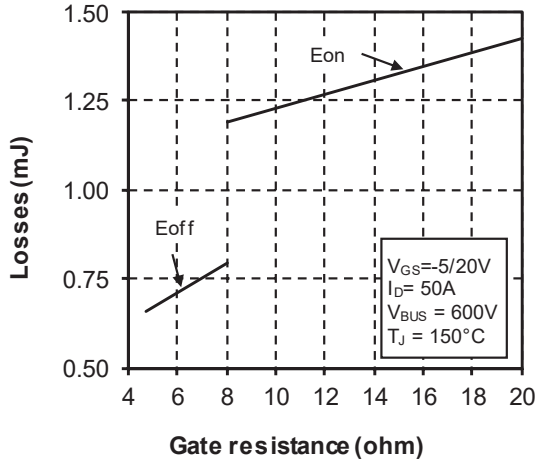


Figure 1-7. Switching Energy vs. Current

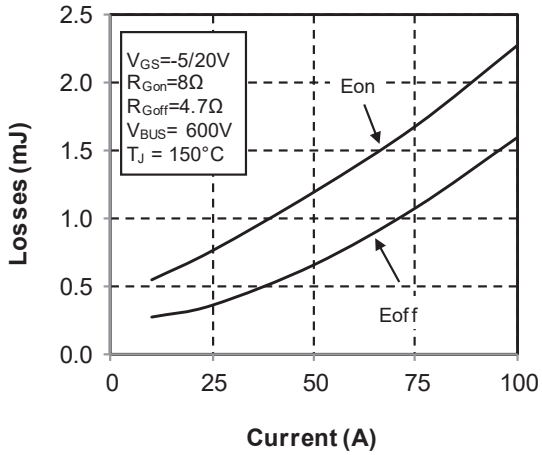


Figure 1-8. Capacitance vs. Drain Source Voltage

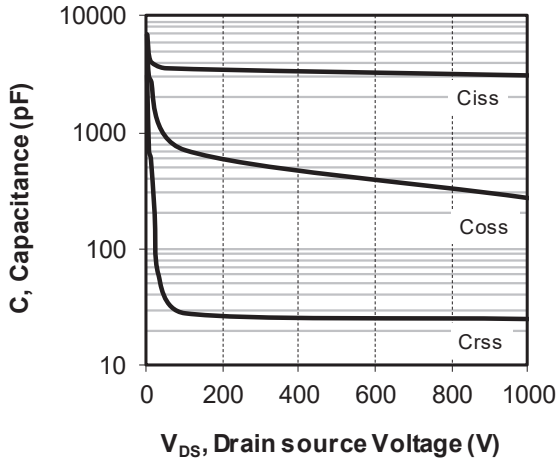


Figure 1-9. Gate Charge vs. Gate Source Voltage

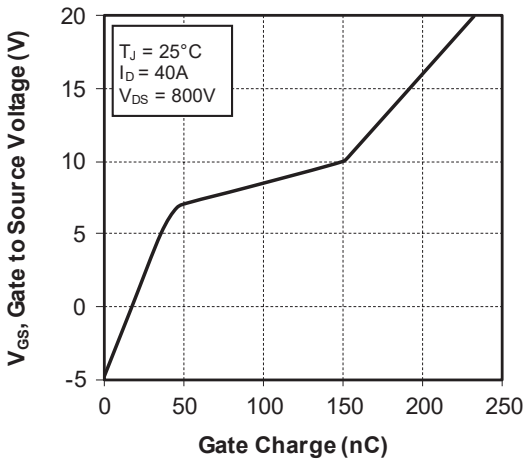


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

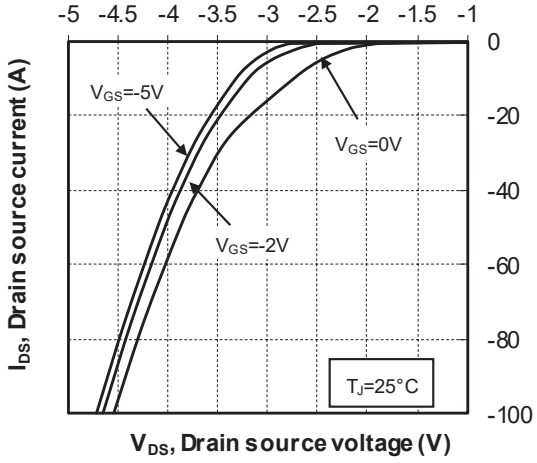


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

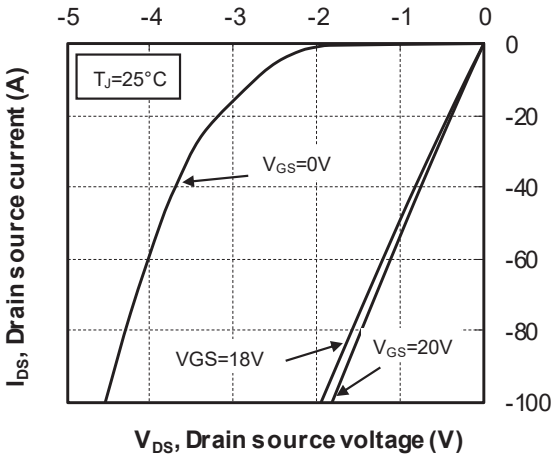


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

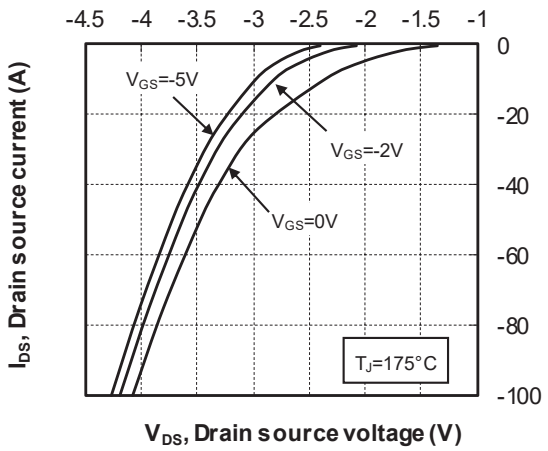


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

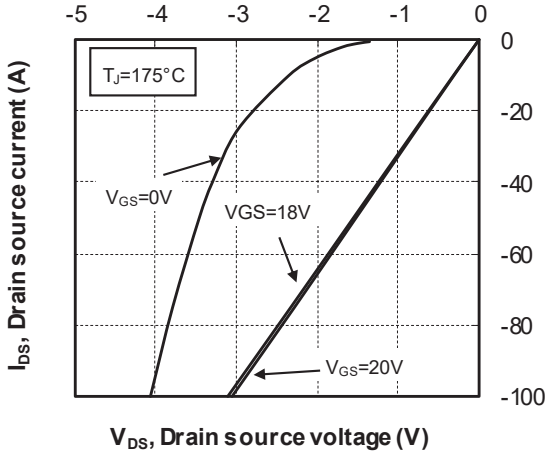
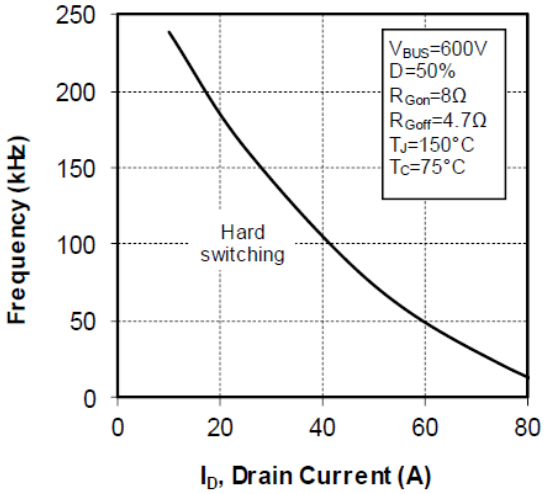


Figure 1-14. Operating Frequency vs. Drain Current



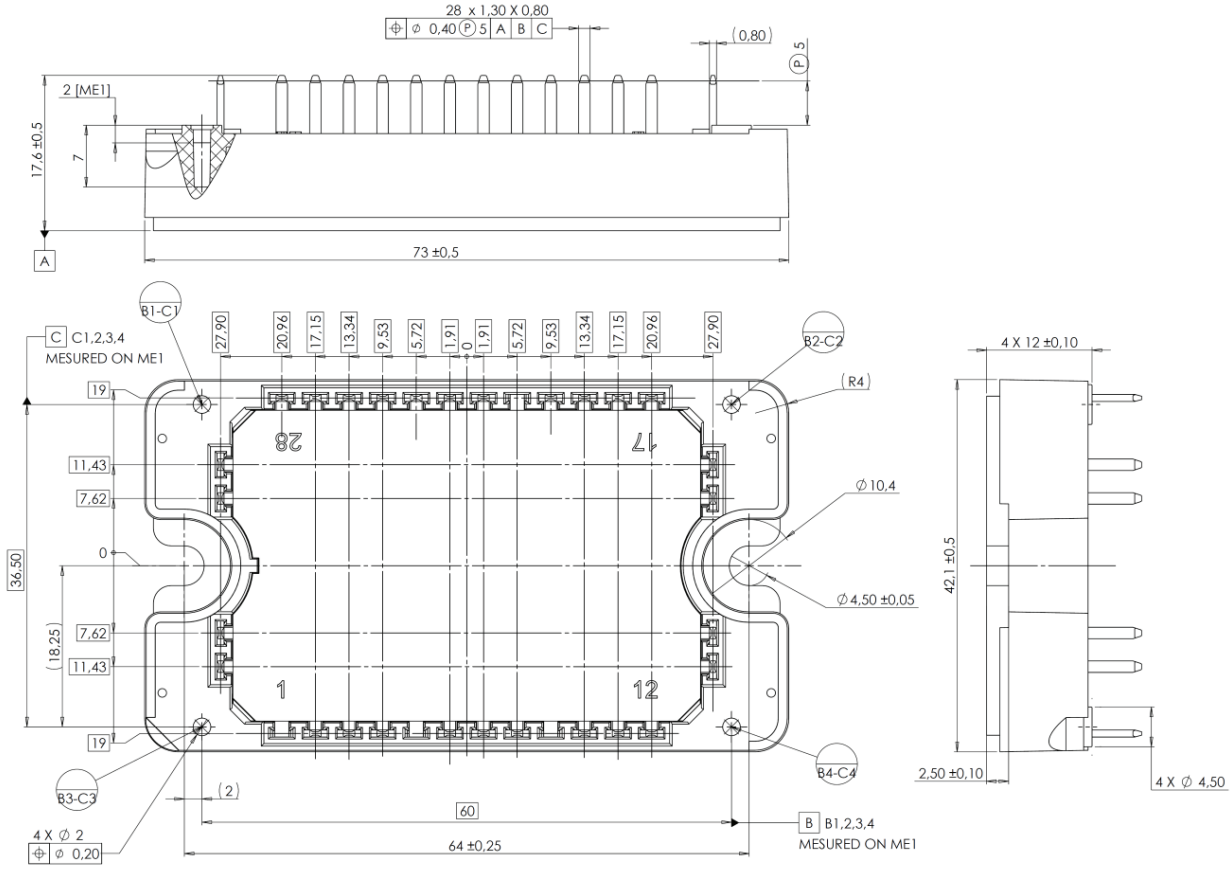
2. Package Specifications

The following section shows the package specification of the MSCSM120TAM31T3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120TAM31T3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See AN3500A—Mounting Instructions for SP1F and SP3F Power Modules for more Information.

3. Revision History

Revision	Date	Description
A	06/2022	Initial Revision

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