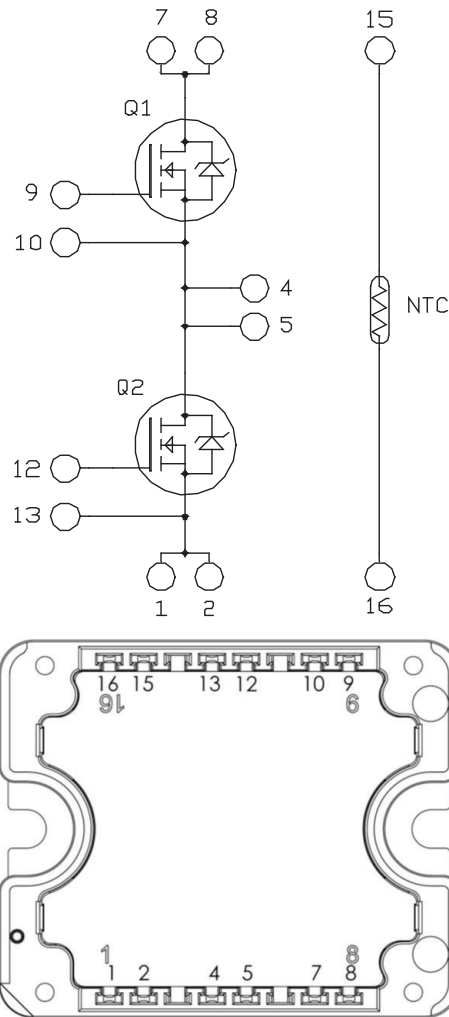


Phase Leg SiC MOSFET Power Module

Product Overview

The MSCSM120AM31T1AG device is a phase leg 1200V, 89A silicon carbide (SiC) MOSFET power module.



Notes:

- Pins 1/2, 4/5, and 7/8 must be shorted together.
- 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 key features of the MSCSM120AM31T1AG device:

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

Benefits

The following are the benefits of MSCSM120AM31T1AG 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

Application

The MSCSM120AM31T1AG 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 MSCSM120AM31T1AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM31T1AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage	1200	V
I_D	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	89
		$T_C = 80\text{ }^\circ\text{C}$	71
I_{DM}	Pulsed drain current	180	
V_{GS}	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	31	m Ω
P_D	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	395

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120AM31T1AG 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	$V_{GS} = 20V$ $I_D = 40A$	$T_J = 25\text{ }^\circ\text{C}$	—	25	31	m Ω
			$T_J = 175\text{ }^\circ\text{C}$	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 3\text{ mA}$	1.8	2.8	—	V	
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20V; V_{DS} = 0V$	—	—	150	nA	

MSCSM120AM31T1AG

Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM31T1AG 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	$f = 1\text{ MHz}$	—	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	$R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$	—	25	—	
E_{on}	Turn-on energy	$V_{GS} = -5V/20V$	—	1.2	—	mJ
E_{off}	Turn-off energy	$V_{Bus} = 600V$ $I_D = 50A$ $R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$				
R_{Gint}	Internal gate resistance		—	0.88	—	Ω
R_{thJC}	Junction-to-case thermal resistance		—	—	0.38	$^{\circ}C/W$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM31T1AG 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	$I_{SD} = 40A; V_{GS} = -5V$	—	90	—	ns
Q_{rr}	Reverse recovery charge	$V_R = 800V; di_F/dt = 1000\text{ A}/\mu\text{s}$	—	550	—	nC
I_{rr}	Reverse recovery current		—	13.5	—	A

1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM31T1AG 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	To heatsink	M4	2	3	N.m
Wt	Package weight	—	80			g

The following table lists the temperature sensor NTC of the MSCSM120AM31T1AG 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 MSCSM120AM31T1AG device.

Figure 1-1. Maximum Thermal Impedance

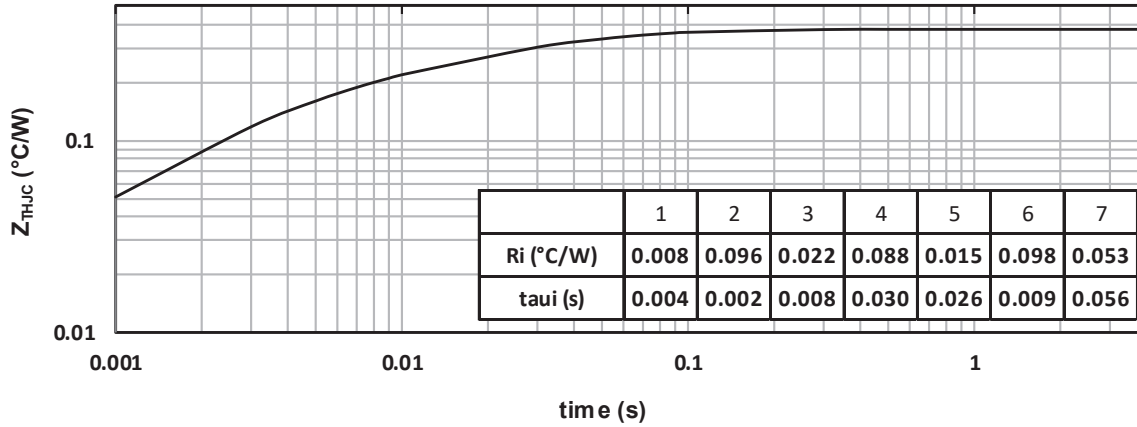


Figure 1-2. Output Characteristics, $T_J = 25^{\circ}C$

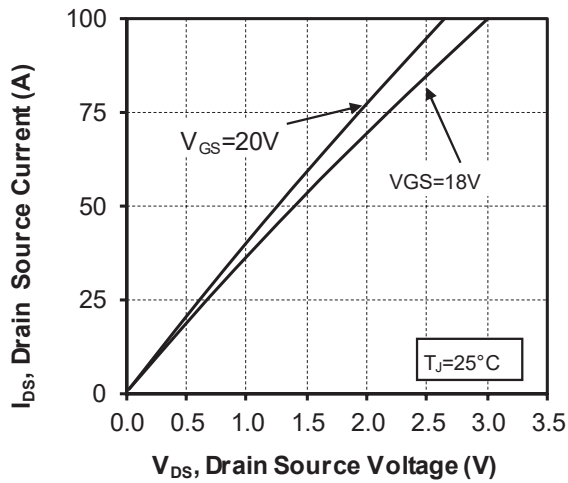


Figure 1-3. Output Characteristics, $T_J = 175^{\circ}C$

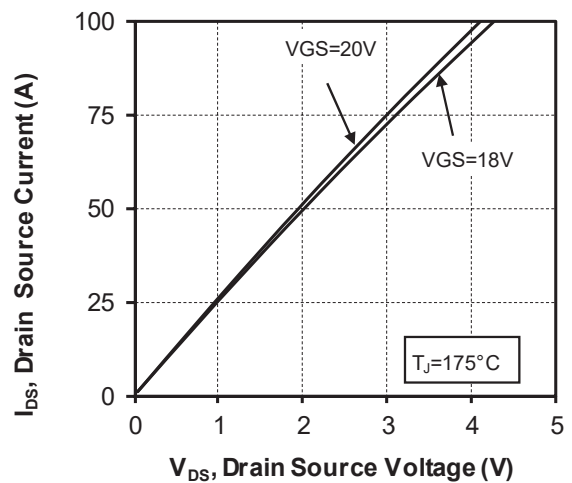


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

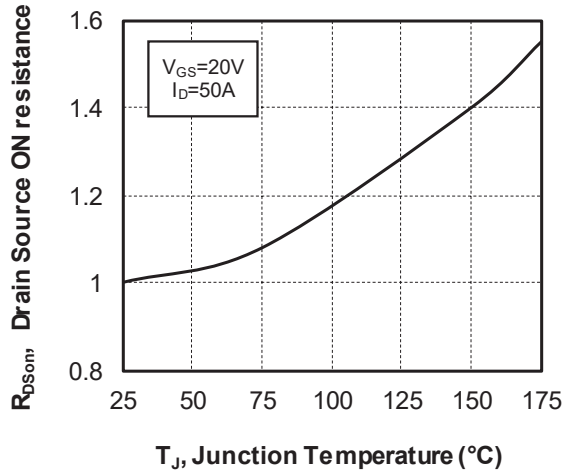


Figure 1-5. Transfer Characteristics

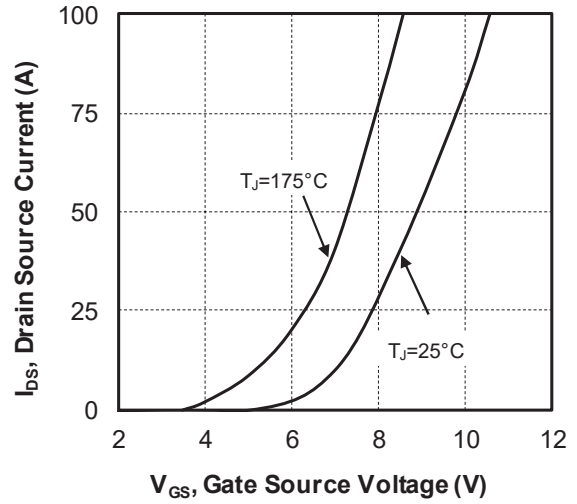


Figure 1-6. Switching Energy vs. Current

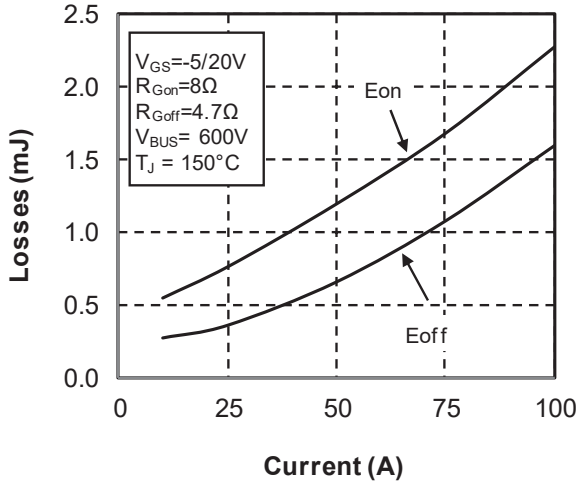


Figure 1-7. Switching Energy vs. Rg

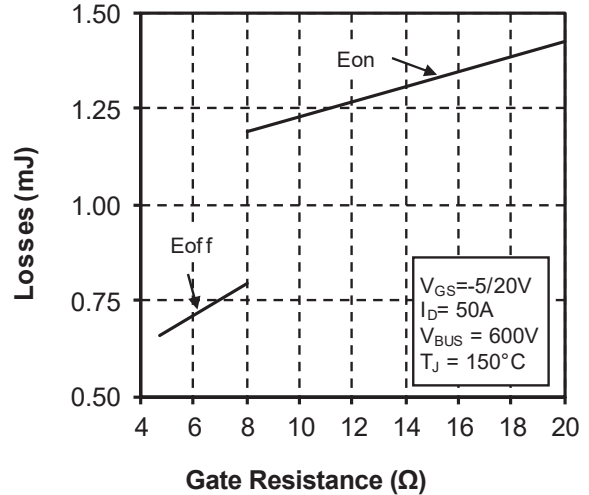


Figure 1-8. Capacitance vs. Drain Source Voltage

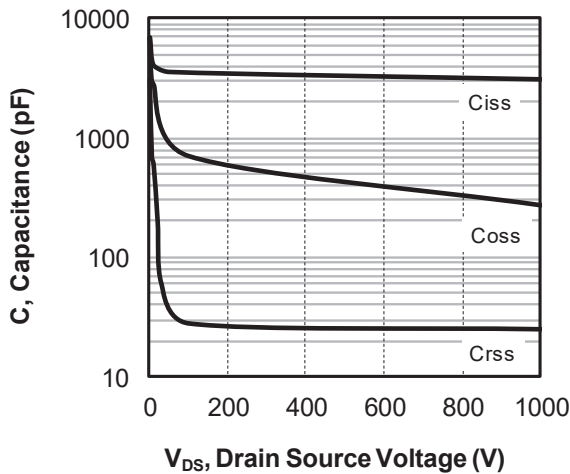


Figure 1-9. Gate Charge vs. Gate Source Voltage

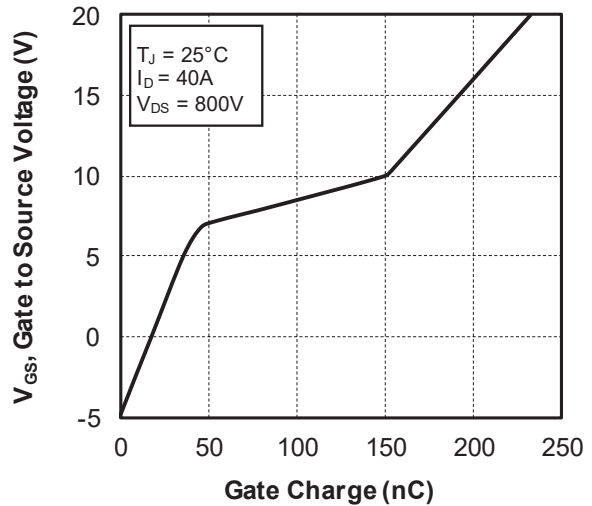


Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

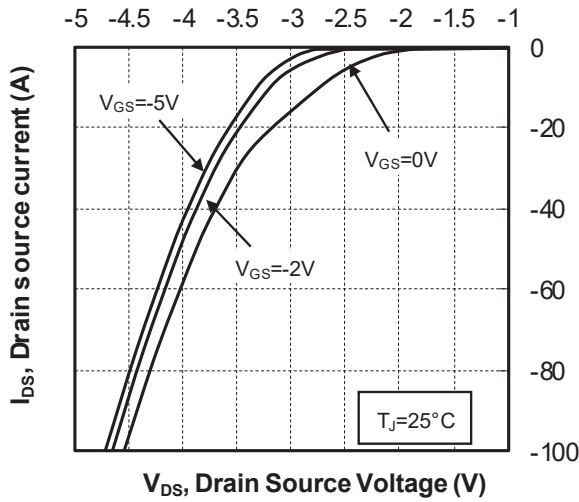


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

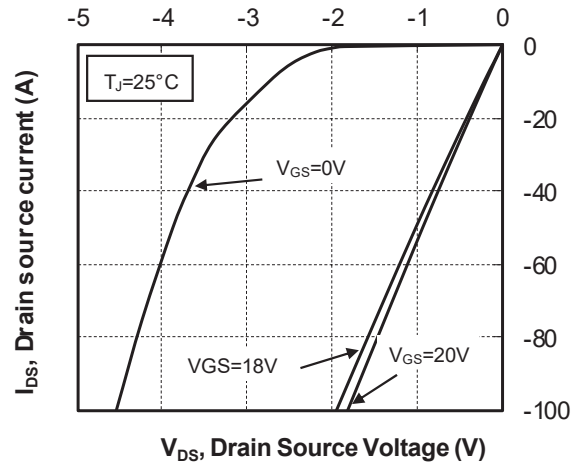


Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

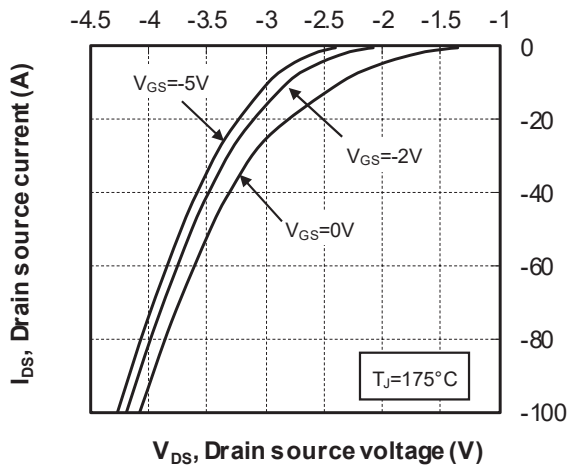


Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

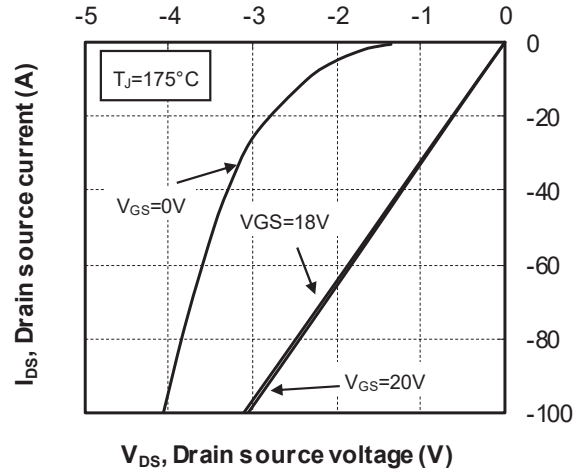
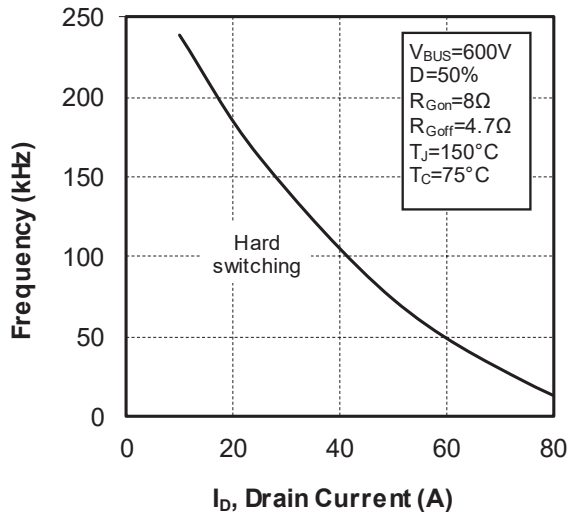


Figure 1-14. Operating Frequency vs. Drain Current



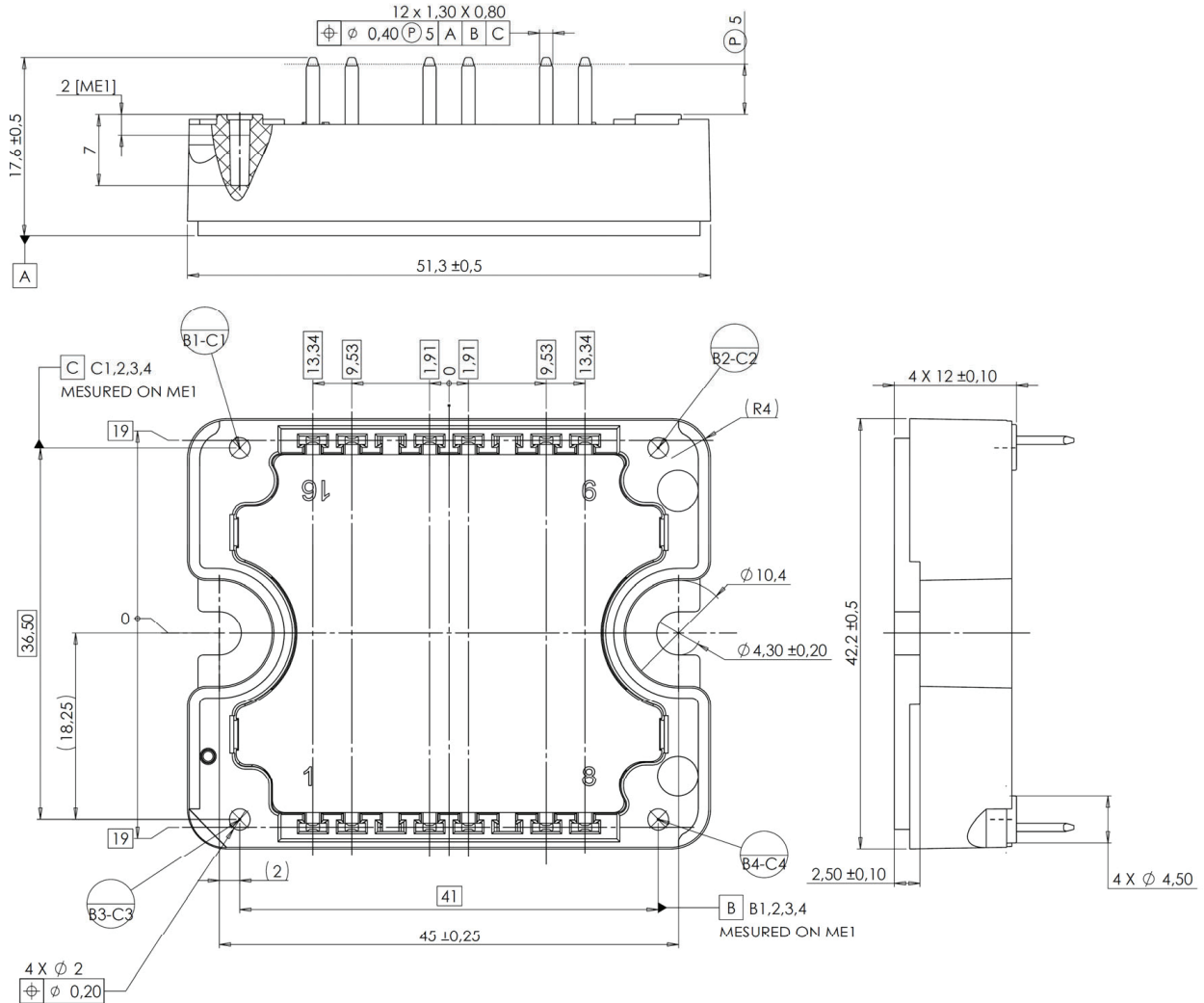
2. Package Specifications

The following section shows the package specification of the MSCSM120AM31T1AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120AM31T1AG 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 Release

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