MSCSM120AM31CT1AG
Datasheet
Phase Leg SiC MOSFET Power Module

January 2020

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1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 1.0

Revision 1.0 is the first publication of this document, published in January 2020.

2 Product Overview

The MSCSM120AM31CT1AG is a phase leg 1200 V/89 A full Silicon Carbide power module.

Figure 1 • MSCSM120AM31CT1AG Electrical Schematic

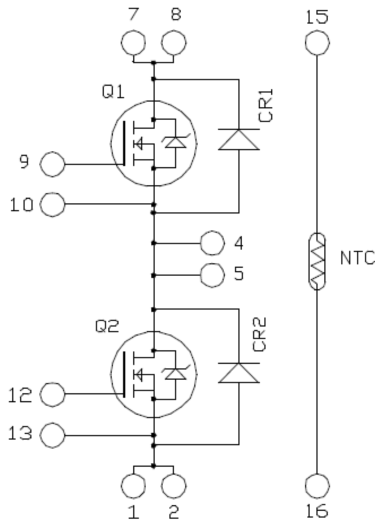
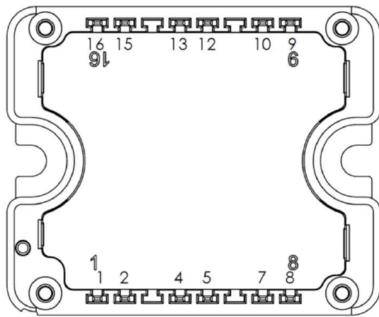


Figure 2 • MSCSM120AM31CT1AG Pinout Location



Pins 1/2 ; 4/5 ; 7/8 must be shorted together

All ratings at T_J = 25 °C unless otherwise specified.

Caution: These devices are sensitive to electrostatic discharge. Proper handling procedures should be followed.

2.1 Features

The following are key features of the MSCSM120AM31CT1AG device:

- SiC Power MOSFET
  - Low RDS(on)
  - High temperature performance
- Silicon carbide (SiC) Schottky diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature-independent switching behavior
  - Positive temperature coefficient on VF
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum nitride (AlN) substrate for improved thermal performance

2.2 Benefits

The following are benefits of the MSCSM120AM31CT1AG 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

2.3 Application

The MSCSM120AM31CT1AG device is designed for the following applications:

- Welding converters
- Switched Mode Power Supplies
- Uninterruptible Power Supplies
- EV motor and traction drive

3 Electrical Specifications

This section shows the electrical specifications of the MSCSM120AM31CT1AG device.

3.1 SiC MOSFET Characteristics (Per MOSFET)

This section describes the electrical characteristics of the MSCSM120AM31CT1AG device.

Table 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		–10/25	V
R_{DSon}	Drain-source ON resistance		31	mΩ
P_D	Power dissipation	T_C = 25 °C	395	W

Table 2 • Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V; V_{DS} = 1200 V			10	100	µA
R_{DSon}	Drain–source on resistance	V_{GS} = 20 V I_D = 40 A	T_J = 25 °C		25	31	mΩ
			T_J = 175 °C		40		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 1 mA		1.8	2.8		V
I_{GSS}	Gate–source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				150	nA

Table 3 • Dynamic Characteristics

Sym-bol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 1000 V f = 1 MHz			3020		pF
C_{oss}	Output capacitance				270		
C_{rss}	Reverse transfer capacitance				25		
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 800 V I_D = 40 A			232		nC
Q_{gs}	Gate–source charge				41		
Q_{gd}	Gate–drain charge				50		
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 800 V I_D = 50 A R_{Gon} = 8Ω; R_{Goff} = 4.7Ω			30		ns
T_r	Rise time				30		
$T_{d(off)}$	Turn-off delay time				50		
T_f	Fall time				25		
E_{on}	Turn on energy	Inductive Switching V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 50 A R_{Gon} = 8Ω R_{Goff} = 4.7Ω	T_J = 150 °C		0.99		mJ
E_{off}	Turn off energy		T_J = 150 °C		0.66		mJ
R_{Gint}	Internal gate resistance				0.88		Ω
R_{thJC}	Junction-to-case thermal resistance					0.38	°C/W

Table 4 • Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0 V; I_{SD} = 40 A		4		V
		V_{GS} = –5 V; I_{SD} = 40 A		4.2		
t_{rr}	Reverse recovery time	I_{SD} = 40 A; V_{GS} = –5 V; V_R = 800 V; diF/dt = 1000 A/µs		90		ns
Q_{rr}	Reverse recovery charge			550		nC
I_{rr}	Reverse recovery current			13.5		A

3.2 Reverse SiC Diode Ratings and Characteristics (Per SiC Diode)

The following section shows the reverse SiC diode ratings and characteristics per diode of the device.

Table 5 • Reverse SiC Diode Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage					1200	V
I_{RRM}	Reverse leakage current	V_R = 1200 V	T_J = 25 °C		10	200	µA
			T_J = 175 °C		150		
I_F	DC forward current		T_C = 100 °C		30		A
V_F	Diode forward voltage	I_F = 30 A	T_J = 25 °C		1.5	1.8	V
			T_J = 175 °C		2.1		
Q_C	Total capacitive charge	V_R = 600 V			130		nC
C	Total capacitance	f = 1 MHz, V_R = 400 V			141		pF
		f = 1 MHz, V_R = 800 V			105		
R_{thJC}	Junction-to-case thermal resistance					0.9	°C/W

3.3 Thermal and Package Characteristics

This section shows the thermal and package characteristics of the device.

Table 6 • Package Characteristics

Symbol	Characteristic			Min	Max	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50/60Hz			4000		V
T_J	Operating junction temperature range			–40	175	°C
T_{JOP}	Recommended junction temperature under switching conditions			–40	T_{Jmax} –25	°C
T_{STG}	Storage temperature range			–40	125	°C
T_C	Operating case temperature			–40	125	°C
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package weight				80	g

Table 7 • Temperature Sensor NTC[1]

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

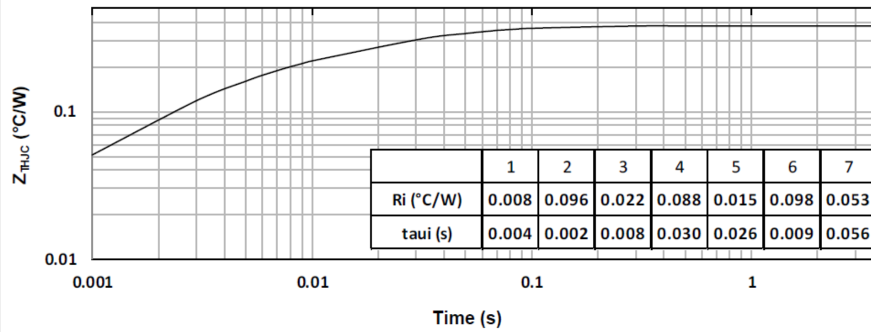
Note:

1. See application note APT0406 on *www.microsemi.com*.

3.4 Typical SiC MOSFET Performance Curves

This section shows the typical performance curves of the MSCSM120AM31CT1AG SiC MOSFET.

Figure 3 • 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 4 • Output Characteristics, T_J = 25 °C

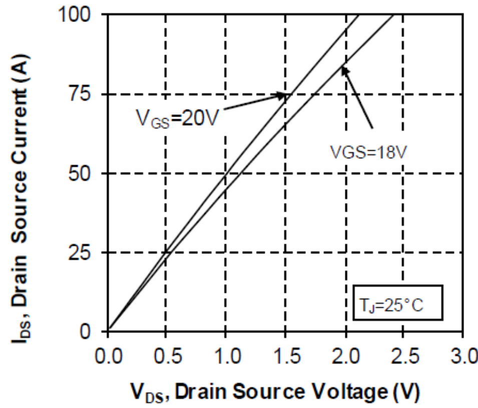


Figure 5 • Output Characteristics, T_J = 175 °C

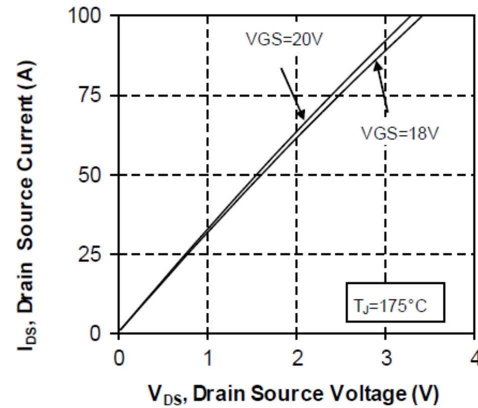


Figure 6 • Normalized RDS(on) vs. Temperature

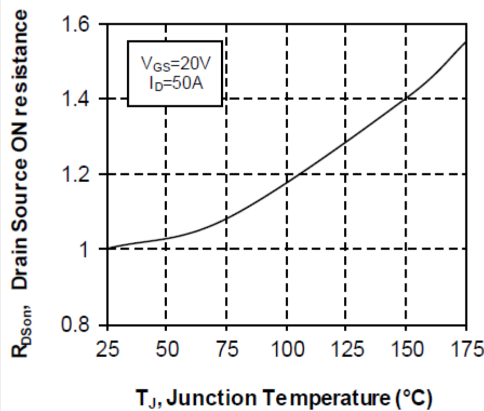


Figure 7 • Transfer Characteristics

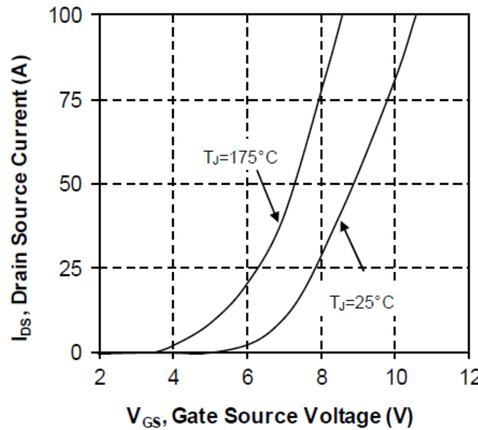


Figure 8 • Switching Energy vs. Rg

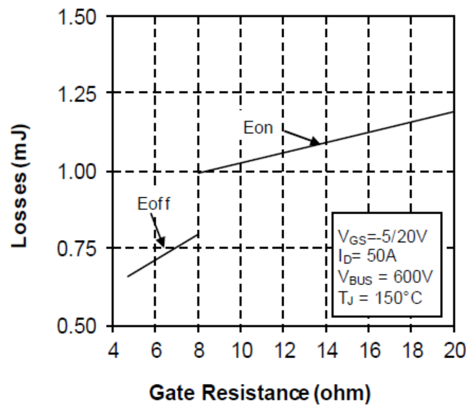


Figure 9 • Switching Energy vs. Current

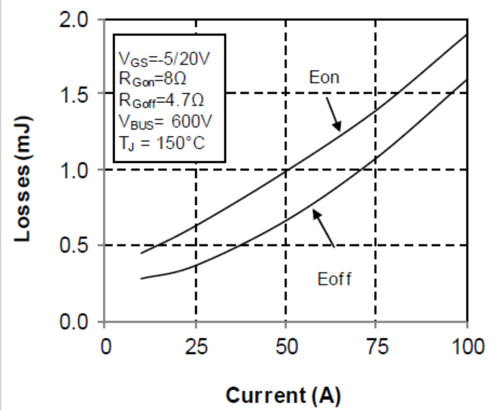


Figure 10 • Capacitance vs. Drain Source Voltage

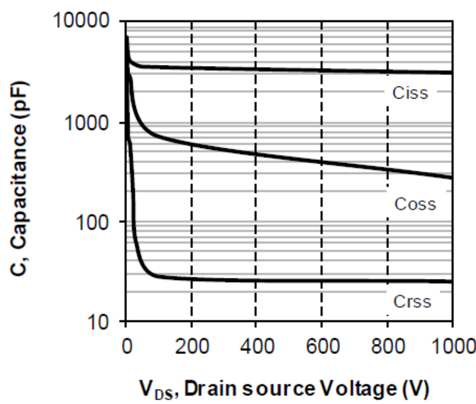


Figure 11 • Gate Charge vs. Gate Source Voltage

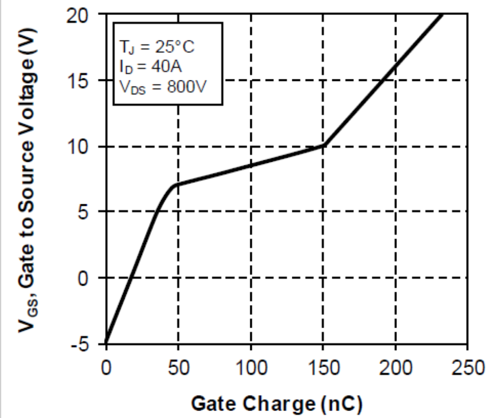


Figure 12 • Body Diode Characteristics, T_J = 25 °C

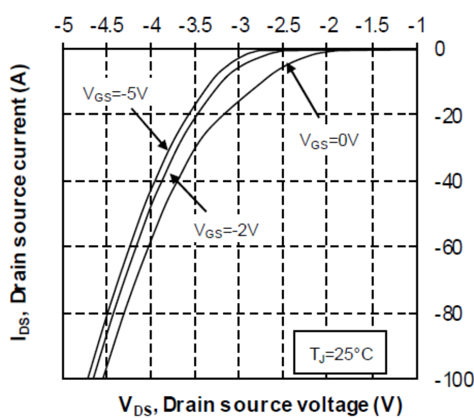


Figure 13 • 3rd Quadrant Characteristics, T_J = 25 °C

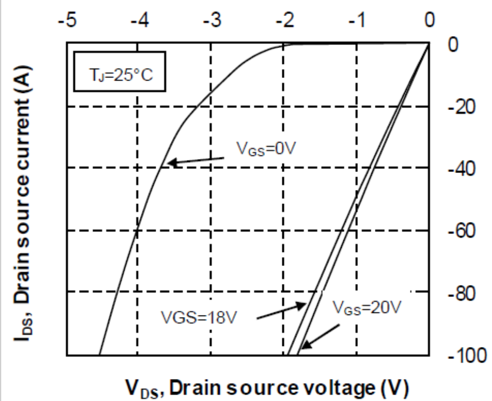


Figure 14 • Body Diode Characteristics, T_J = 175 °C

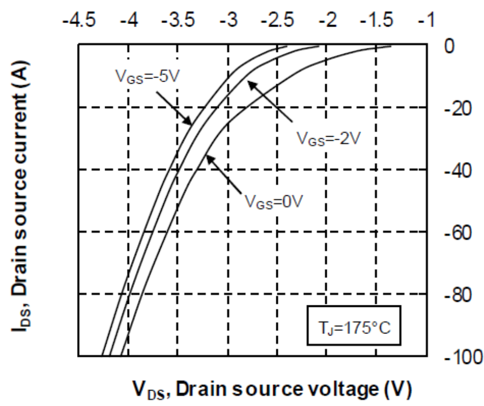


Figure 15 • 3rd Quadrant Characteristics, T_J = 175 °C

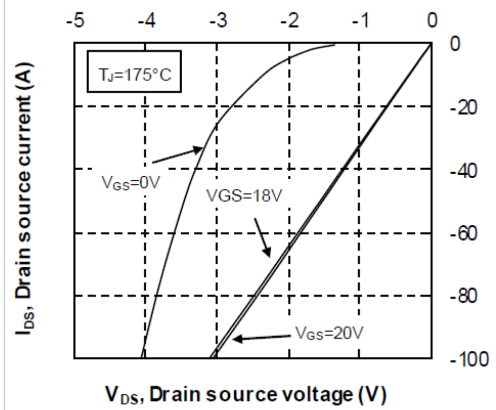
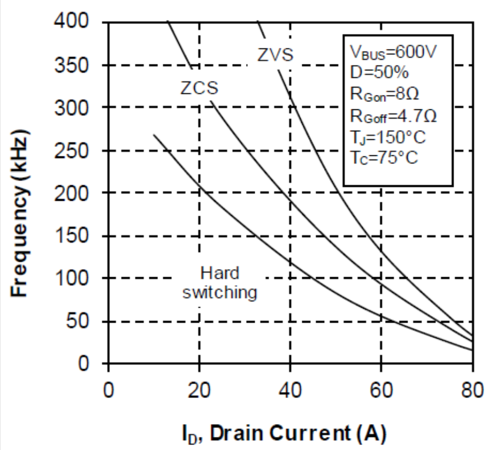


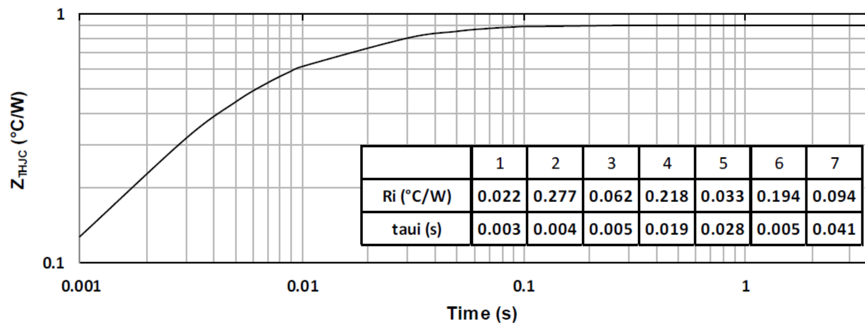
Figure 16 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

This section shows the typical performance curves of the MSCSM120AM31CT1AG SiC diode.

Figure 17 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.022	0.277	0.062	0.218	0.033	0.194	0.094
taui (s)	0.003	0.004	0.005	0.019	0.028	0.005	0.041

Figure 18 • Forward Characteristics

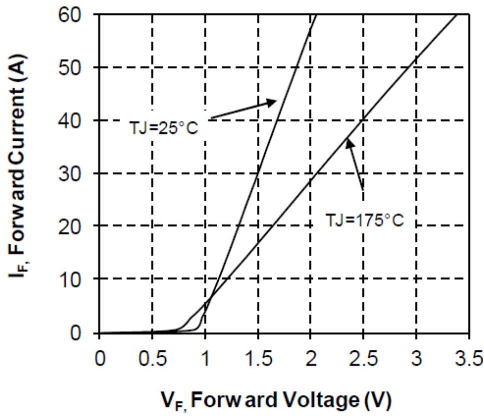
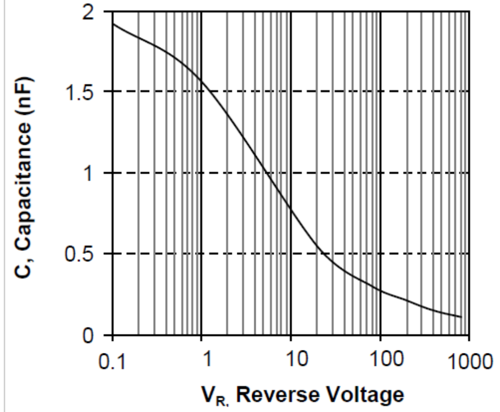


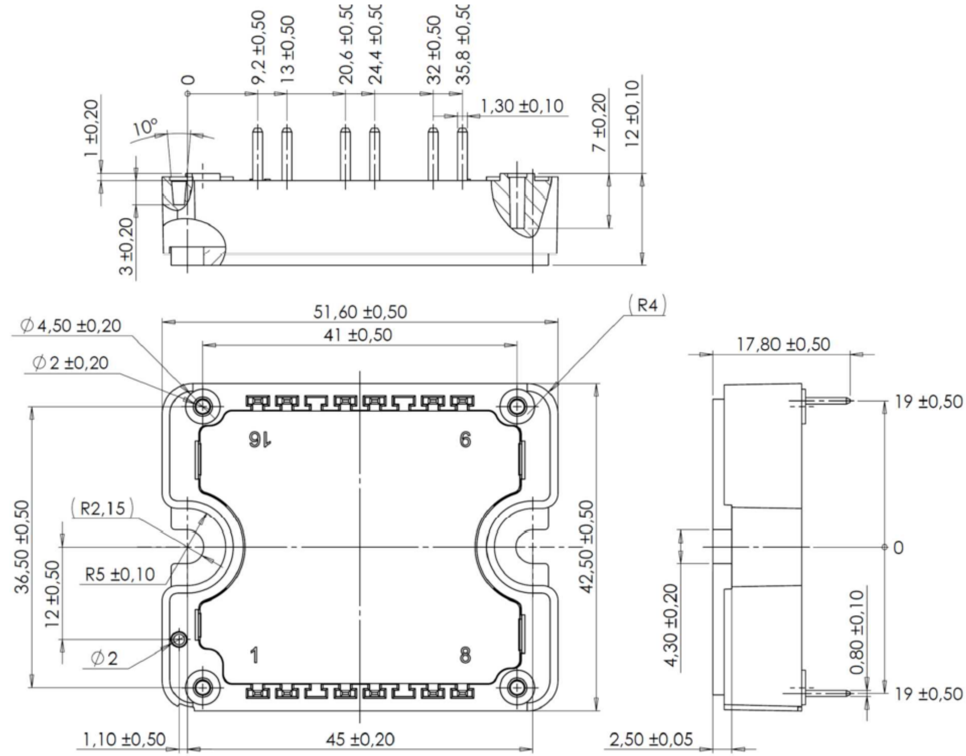
Figure 19 • Capacitance vs. Reverse Voltage



4 Package Specifications

This section shows the package outline of the MSCSM120AM31CT1AG device. All dimensions are in millimeters.

Figure 20 • Package Outline



Microsemi
2355 W. Chandler Blvd.
Chandler, AZ 85224 USA

Within the USA: +1 (480) 792-7200
Fax: +1 (480) 792-7277

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