MSCSM120AM027CT6AG

Datasheet

Phase Leg SiC Power Module

January 2020

Microsemi

a Microchip company

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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 MSCSM120AM027CT6AG is a phase leg 1200 V/733 A full Silicon Carbide power module.

Figure 1 • MSCSM120AM027CT6AG Electrical Schematic

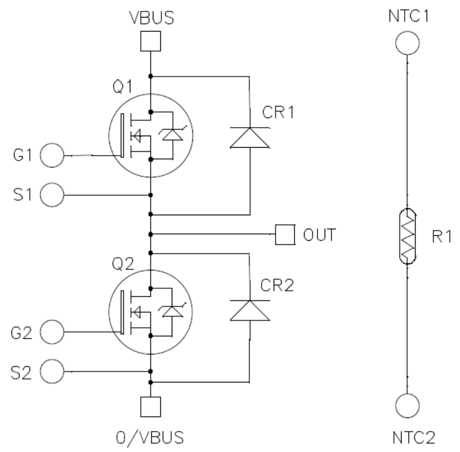
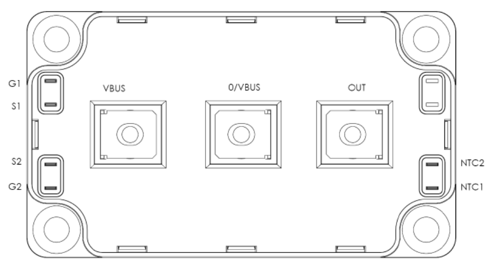


Figure 2 • MSCSM120AM027CT6AG Pinout Location



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 MSCSM120AM027CT6AG 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
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum nitride (AlN) substrate for improved thermal performance

2.2 Benefits

The following are benefits of the MSCSM120AM027CT6AG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS Compliant

2.3 Application

The MSCSM120AM027CT6AG 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 MSCSM120AM027CT6AG device.

3.1 SiC MOSFET Characteristics (Per MOSFET)

This section describes the electrical characteristics of the MSCSM120AM027CT6AG 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	733[1]	A
		T_C = 80 °C	584[1]	A
I_{DM}	Pulsed drain current		1400	A
V_{GS}	Gate-source voltage		–10/25	V
R_{DSon}	Drain-source ON resistance		3.5	mΩ
P_D	Power dissipation	T_C = 25 °C	2970	W

Note:

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

Table 2 • Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0V; V_{DS} = 1200 V			90	900	µA
R_{DSon}	Drain–source on resistance	V_{GS} = 20 V I_D = 360 A	T_J = 25 °C		2.78	3.5	mΩ
			T_J = 175 °C		4.45		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 9 mA		1.8	2.8		V
I_{GSS}	Gate–source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				900	nA

Table 3 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 1000 V f = 1 MHz			27		nF
C_{oss}	Output capacitance				2.43		nF
C_{rss}	Reverse transfer capacitance				0.23		nF
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 800 V I_D = 360 A			2088		nC
Q_{gs}	Gate–source charge				369		nC
Q_{gd}	Gate–drain charge				450		nC
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 450 A TJ = 150 °C R_{Gon} = 0.9Ω; R_{Goff} = 0.5Ω			56		ns
T_r	Rise time				55		ns
$T_{d(off)}$	Turn-off delay time				166		ns
T_f	Fall time				67		ns
E_{on}	Turn on energy	Inductive Switching V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 450 A R_{Gon} = 0.9Ω R_{Goff} = 0.5Ω	T_J = 150 °C		9.2		mJ
E_{off}	Turn off energy		T_J = 150 °C		8.2		mJ
R_{Gint}	Internal gate resistance				0.65		Ω
R_{thJC}	Junction-to-case thermal resistance					0.051	°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} = 360 A		4		V
		V_{GS} = –5 V; I_{SD} = 360 A		4.2		
t_{rr}	Reverse recovery time	I_{SD} = 360 A; V_{GS} = –5 V; V_R = 600 V; diF/dt = 9000 A/µs		90		ns
Q_{rr}	Reverse recovery charge			4950		nC
I_{rr}	Reverse recovery current			122		A

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

This section shows the SiC Schottky diode ratings and characteristics of the device.

Table 5 • SiC Schottky Diode Ratings and 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		90	1800	µA
			T_J = 175 °C		1350		
I_F	Forward current		T_C = 95 °C		270		A
V_F	Diode forward voltage	I_F = 270 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			1170		nC
C	Total capacitance	f = 1 MHz, V_R = 400 V			1269		pF
		f = 1 MHz, V_R = 800 V			945		
R_{thJC}	Junction-to-case thermal resistance					0.12	°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	
T_{STG}	Storage temperature range			–40	125	
T_C	Operating case temperature			–40	125	
Torque	Mounting torque	For terminals	M6	3	5	N.m
		To heatsink	M6	3	5	
Wt	Package weight				350	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

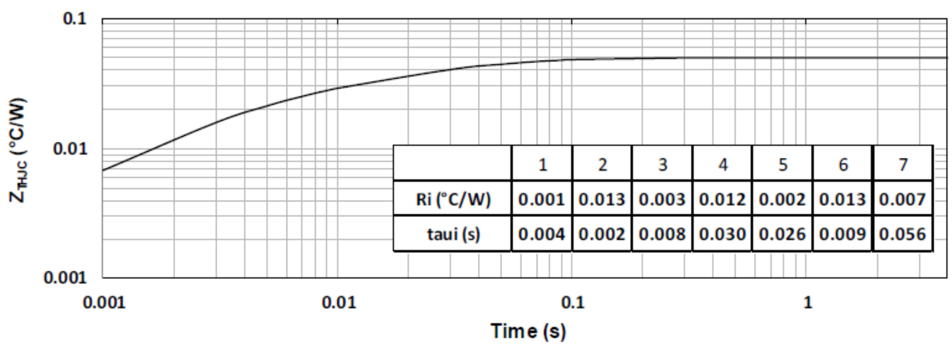
Note:

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 MSCSM120AM027CT6AG SiC MOSFET.

Figure 3 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.001	0.013	0.003	0.012	0.002	0.013	0.007
taui (s)	0.004	0.002	0.008	0.030	0.026	0.009	0.056

Figure 4 • Output Characteristics, T_J = 25 °C

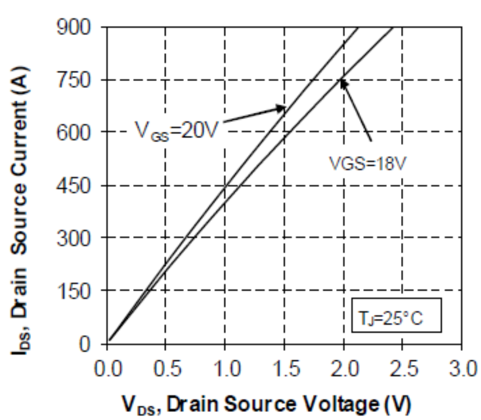


Figure 5 • Output Characteristics, T_J = 175 °C

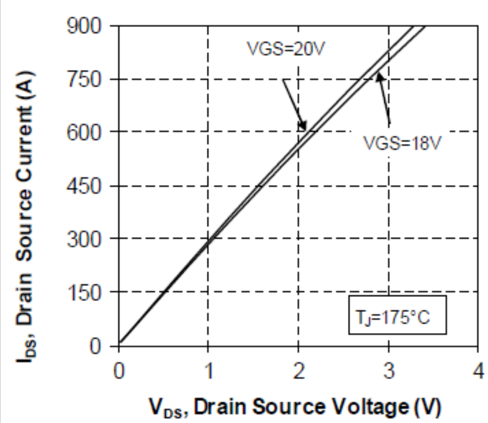


Figure 6 • Normalized RDS(on) vs. Temperature

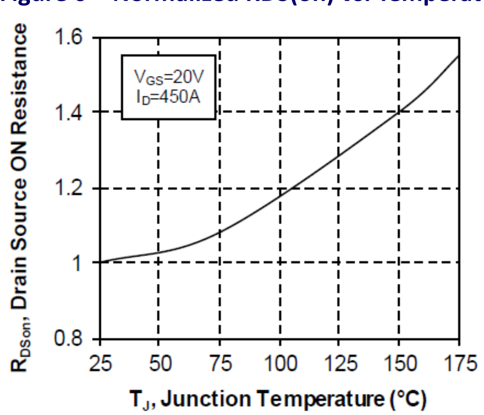


Figure 7 • Transfer Characteristics

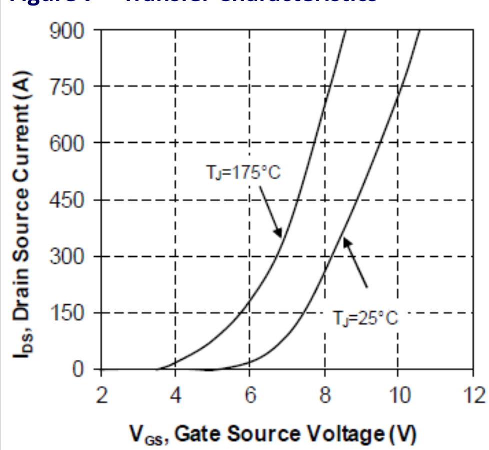


Figure 8 • Switching Energy vs. Rg

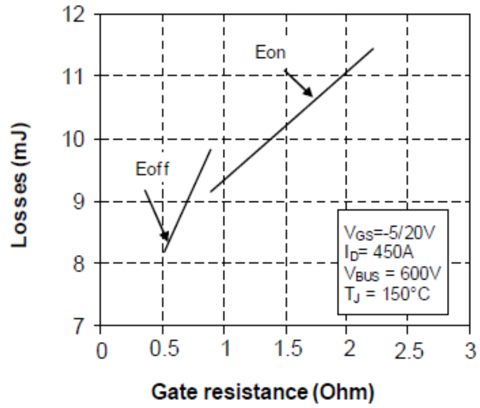


Figure 9 • Switching Energy vs. Current

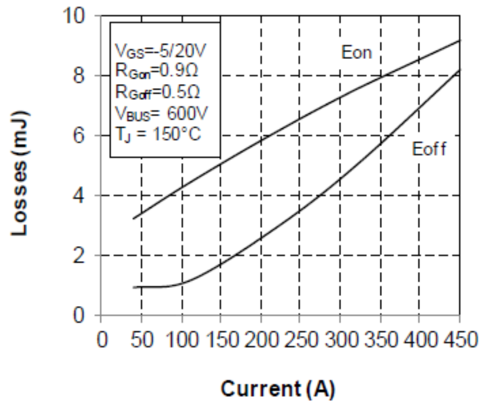


Figure 10 • Capacitance vs. Drain Source Voltage

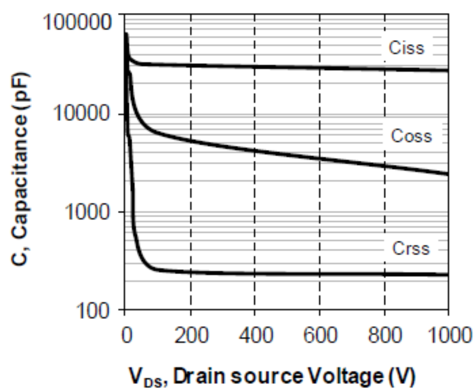


Figure 11 • Gate Charge vs. Gate Source Voltage

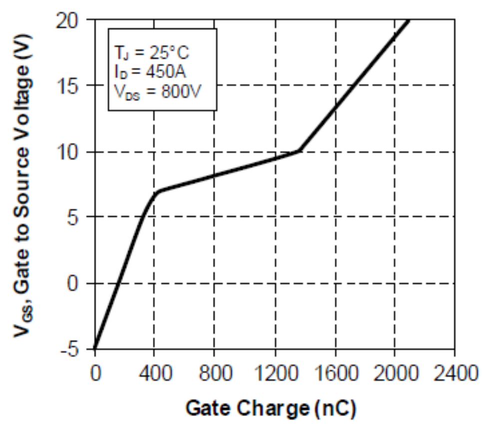


Figure 12 • Body Diode Characteristics, T_J = 25 °C

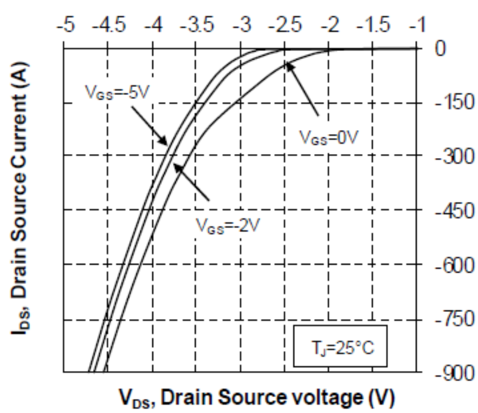


Figure 13 • 3rd Quadrant Characteristics, T_J = 25 °C

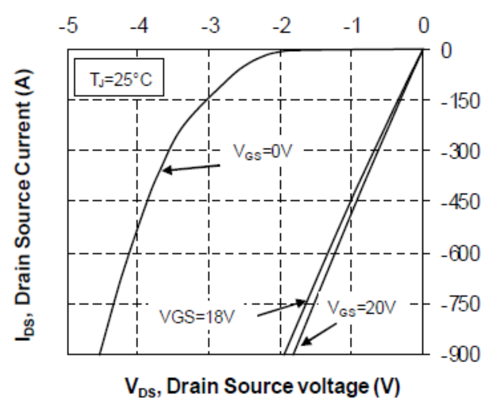


Figure 14 • Body Diode Characteristics, T_J = 175 °C

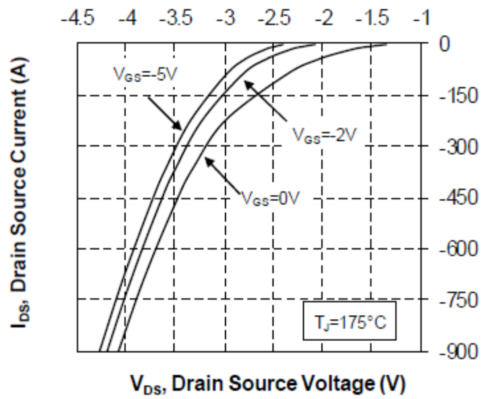


Figure 15 • 3rd Quadrant Characteristics, T_J = 175 °C

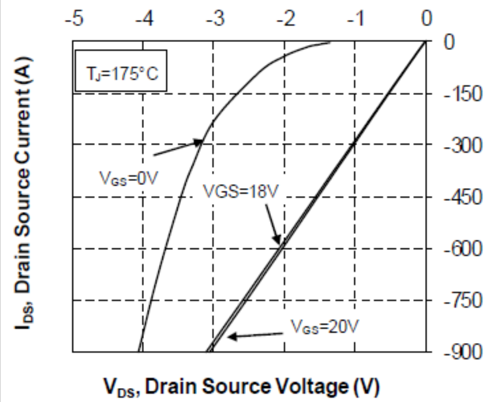
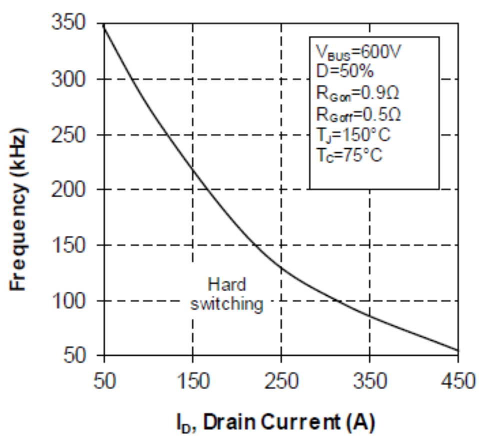


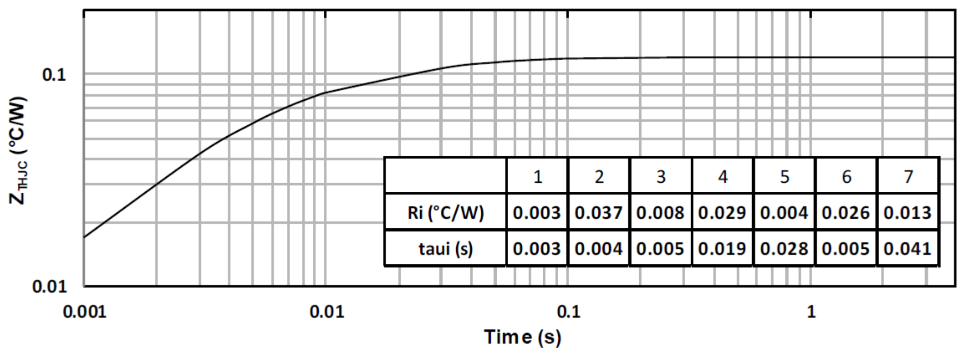
Figure 16 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

This section shows the typical performance curves of the MSCSM120AM027CT6AG SiC diode.

Figure 17 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.003	0.037	0.008	0.029	0.004	0.026	0.013
taui (s)	0.003	0.004	0.005	0.019	0.028	0.005	0.041

Figure 18 • Forward Characteristics

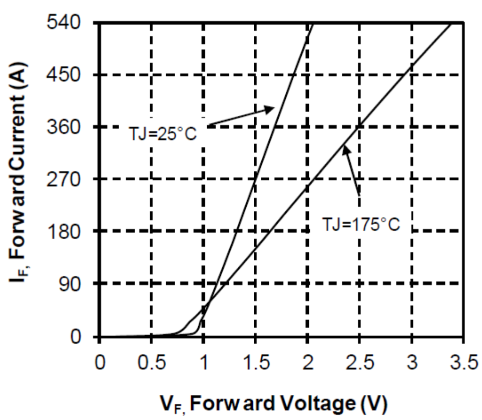
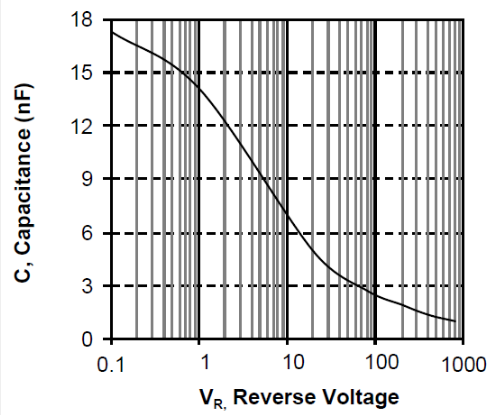


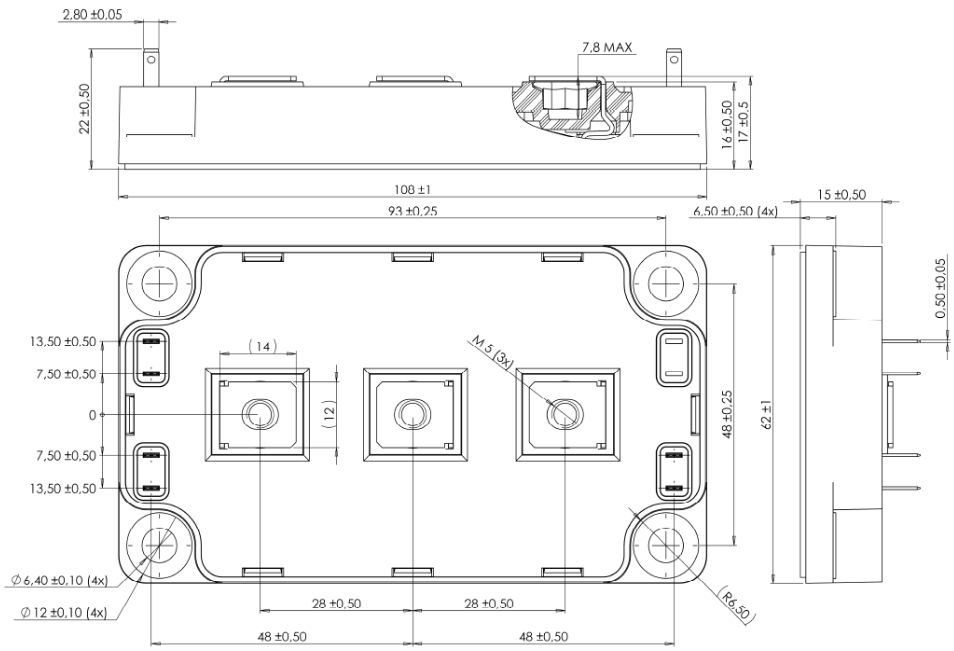
Figure 19 • Capacitance vs. Reverse Voltage



4 Package Specifications

This section shows the package outline of the MSCSM120AM027CT6AG device. All dimensions are in millimeters.

Figure 20 • Package Outline



See application note APT0601 – Mounting Instructions for SP6 Power Modules on *www.microsemi.com*.

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