MSCSM70HM19CT3AG

Datasheet

Full Bridge SiC MOSFET Power Module

April 2020

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 April 2020.

2 Product Overview

The MSCSM70HM19CT3AG is a full bridge 700 V/124 A full Silicon Carbide power module.

Figure 1 • MSCSM70HM19CT3AG Electrical Schematic

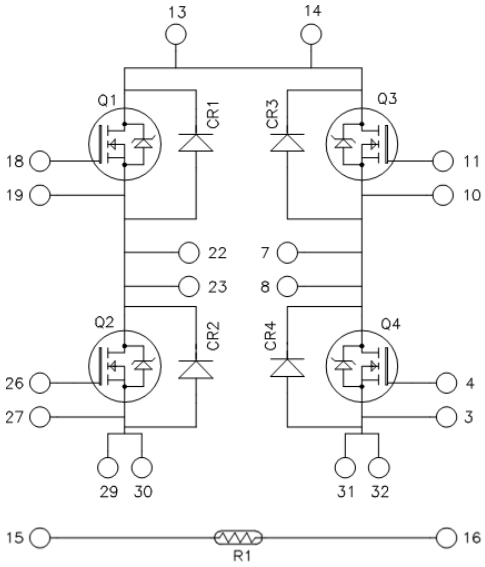
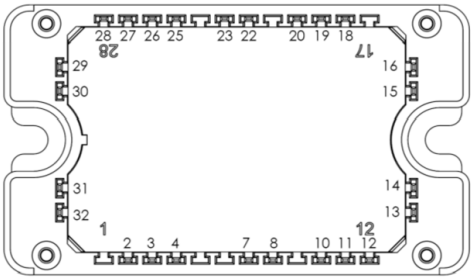


Figure 2 • MSCSM70HM19CT3AG Pinout Location



All multiple inputs & outputs must be shorted together
Example: 13/14 ; 29/30 ; 22/23 …

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 MSCSM70HM19CT3AG device:

- SiC Power MOSFET
  - High-speed switching
  - Low RDS(on)
  - Ultra low loss
- 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
- 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 MSCSM70HM19CT3AG 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

2.3 Applications

The MSCSM70HM19CT3AG 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 MSCSM70HM19CT3AG device.

3.1 SiC MOSFET Characteristics (Per MOSFET)

This section describes the electrical characteristics of the MSCSM70HM19CT3AG device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-source voltage		700	V
I_D	Continuous drain current	T_C = 25 °C	124[1]	A
		T_C = 80 °C	98[1]	A
I_{DM}	Pulsed drain current		250	A
V_{GS}	Gate-source voltage		–10/25	V
R_{DSon}	Drain-source ON resistance		19	mΩ
P_D	Power dissipation	T_C = 25 °C	365	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} = 700 V				100	µA
R_{DSon}	Drain–source on resistance	V_{GS} = 20 V I_D = 40 A	T_J = 25 °C		15	19	mΩ
			T_J = 175 °C		18.8		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 4 mA		1.9	2.4		V
I_{GSS}	Gate–source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				150	nA

Table 3 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 700 V f = 1 MHz			4500		pF
C_{oss}	Output capacitance				510		pF
C_{rss}	Reverse transfer capacitance				29		pF
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 470 V I_D = 40 A			215		nC
Q_{gs}	Gate–source charge				58		nC
Q_{gd}	Gate–drain charge				35		nC
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 400 V I_D = 80 A TJ = 150 °C R_{Gon} = 27 Ω; R_{Goff} = 4.7 Ω			40		ns
T_r	Rise time				35		ns
$T_{d(off)}$	Turn-off delay time				50		ns
T_f	Fall time				20		ns
E_{on}	Turn on energy	Inductive Switching V_{GS} = –5/20 V V_{Bus} = 400 V I_D = 80 A R_{Gon} = 27 Ω R_{Goff} = 4.7 Ω	T_J = 150 °C		545		µJ
E_{off}	Turn off energy		T_J = 150 °C		186		µJ
R_{Gint}	Internal gate resistance				0.69		Ω
R_{thJC}	Junction-to-case thermal resistance					0.41	°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		3.4		V
		V_{GS} = –5 V; I_{SD} = 40 A		3.8		
t_{rr}	Reverse recovery time	I_{SD} = 40 A; V_{GS} = –5 V; V_R = 400 V; diF/dt = 1000 A/µs		38		ns
Q_{rr}	Reverse recovery charge			318		nC
I_{rr}	Reverse recovery current			14.8		A

3.2 SiC Schottky Diode Ratings Characteristics

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					700	V
I_{RRM}	Reverse leakage current	V_R = 700 V	T_J = 25 °C		15	200	µA
			T_J = 175 °C		250		
I_F	Forward current		T_C = 80 °C		50		A
V_F	Diode forward voltage	I_F = 50 A	T_J = 25 °C		1.5	1.8	V
			T_J = 175 °C		1.9		
Q_C	Total capacitive charge	V_R = 400 V			133		nC
C	Total capacitance	f = 1 MHz, V_R = 200 V			248		pF
		f = 1 MHz, V_R = 400 V			216		
R_{thJC}	Junction-to-case thermal resistance					0.86	°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	To heatsink	M4	2	3	N.m
Wt	Package weight				110	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 MSCSM70HM19CT3AG SiC MOSFET.

Figure 3 • Maximum Thermal Impedance

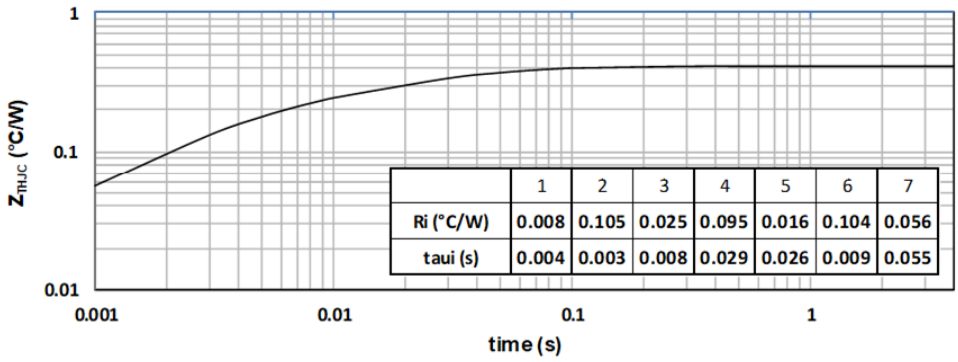


Figure 4 • Output Characteristics, T_J = 25 °C

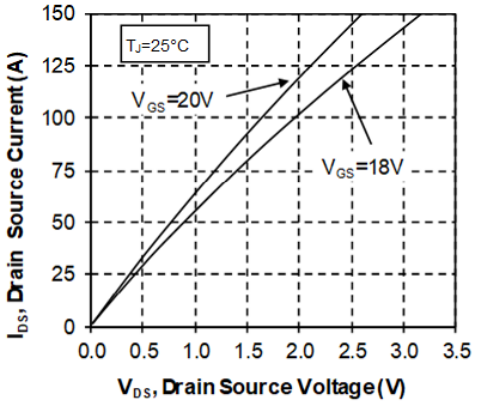


Figure 5 • Output Characteristics, T_J = 175 °C

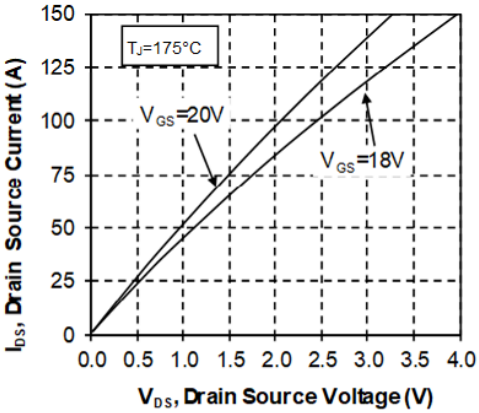


Figure 6 • Normalized RDS(on) vs. Temperature

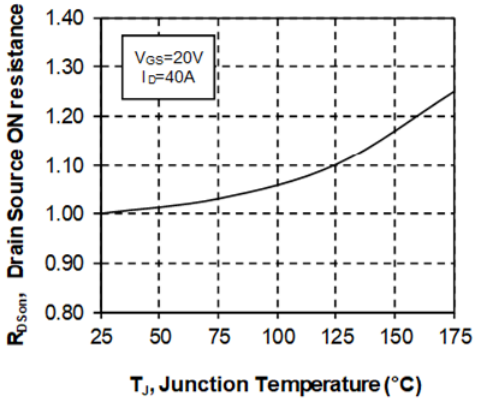


Figure 7 • Transfer Characteristics

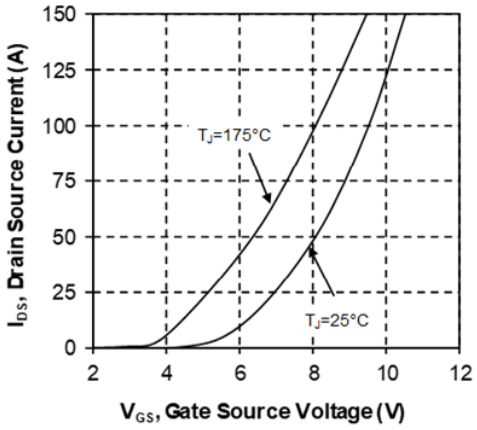


Figure 8 • Capacitance vs. Drain Source Voltage

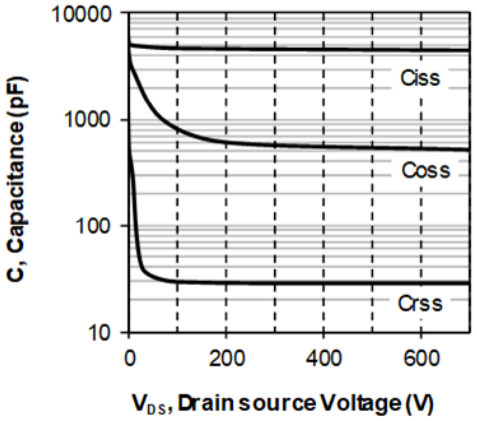


Figure 9 • Gate Charge vs. Gate Source Voltage

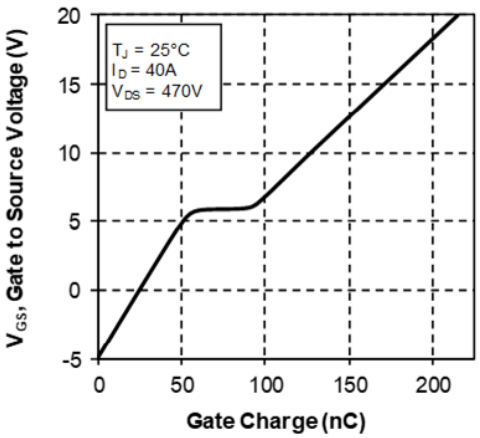


Figure 10 • Body Diode Characteristics, T_J = 25 °C

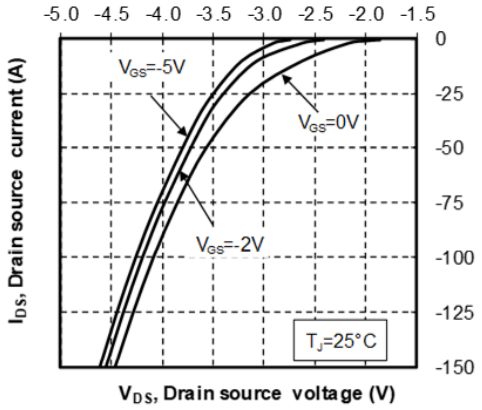


Figure 11 • 3rd Quadrant Characteristics, T_J = 25 °C

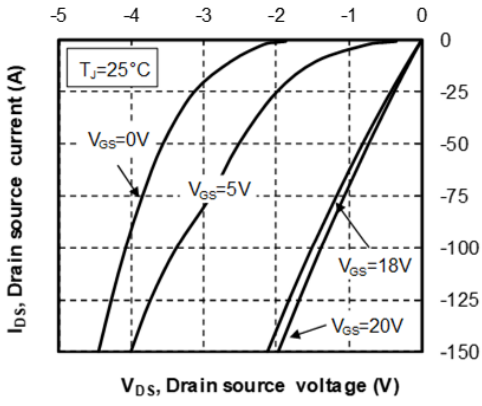


Figure 12 • Body Diode Characteristics, T_J = 175 °C

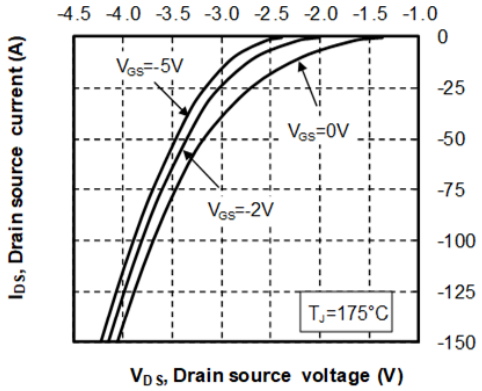


Figure 13 • 3rd Quadrant Characteristics, T_J = 175 °C

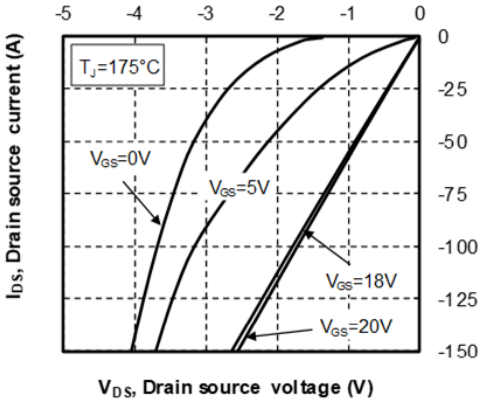


Figure 14 • Switching Energy vs. Current

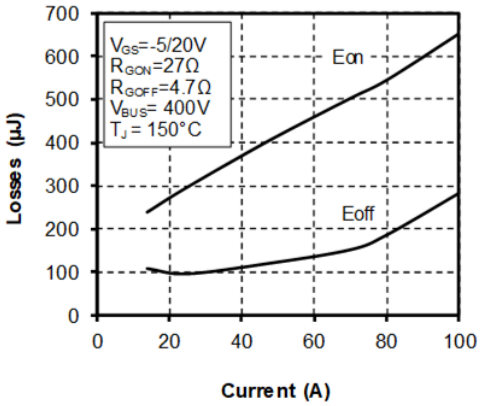


Figure 15 • Turn-on Energy vs. Rg

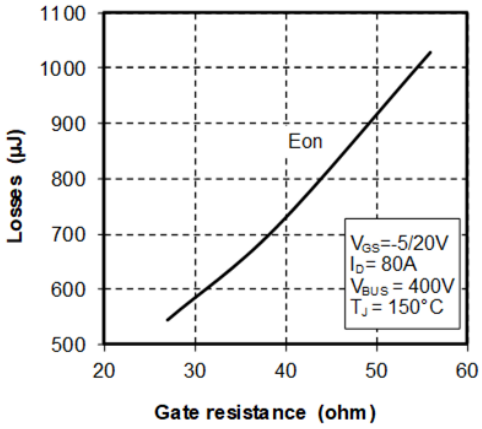


Figure 16 • Turn-off Energy vs. Rg

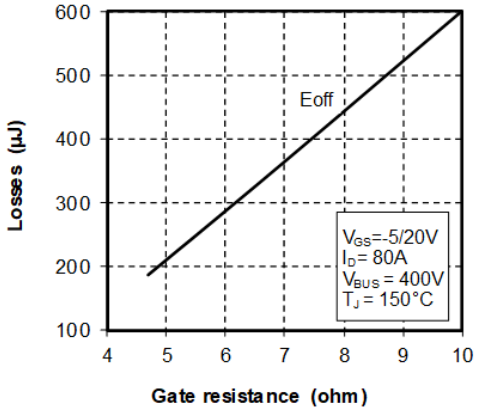
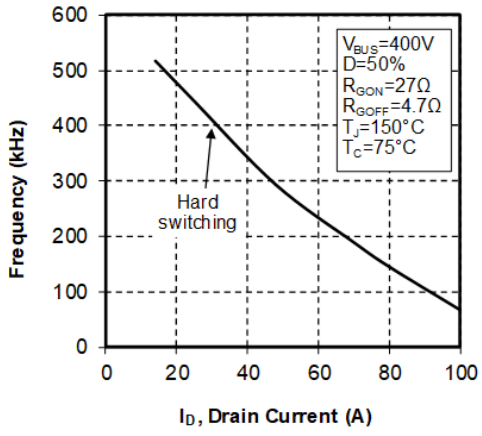


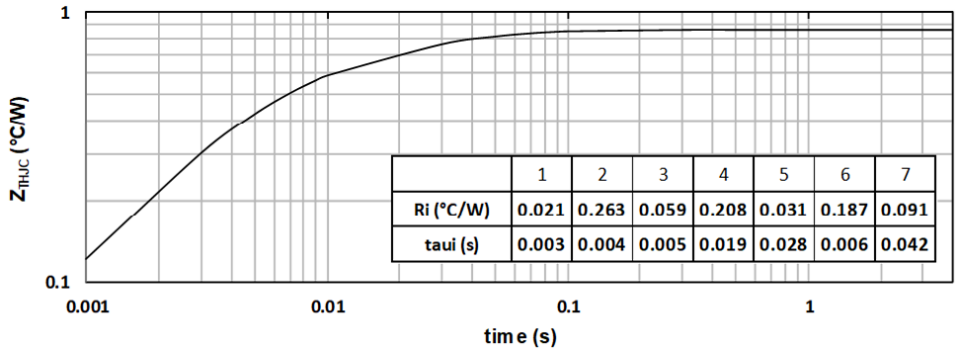
Figure 17 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance

This section shows the typical performance curves of the MSCSM70HM19CT3AG SiC diode.

Figure 18 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.021	0.263	0.059	0.208	0.031	0.187	0.091
taui (s)	0.003	0.004	0.005	0.019	0.028	0.006	0.042

Figure 19 • Forward Characteristics

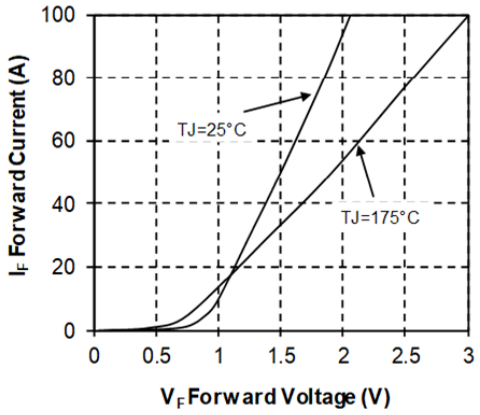
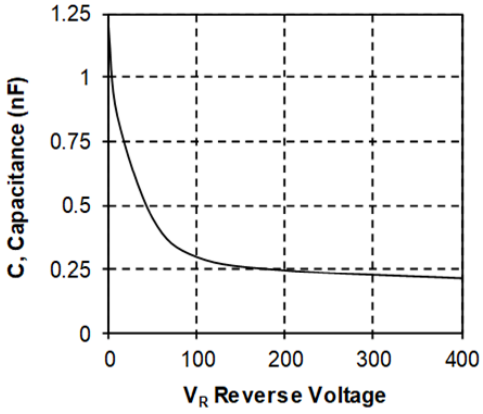


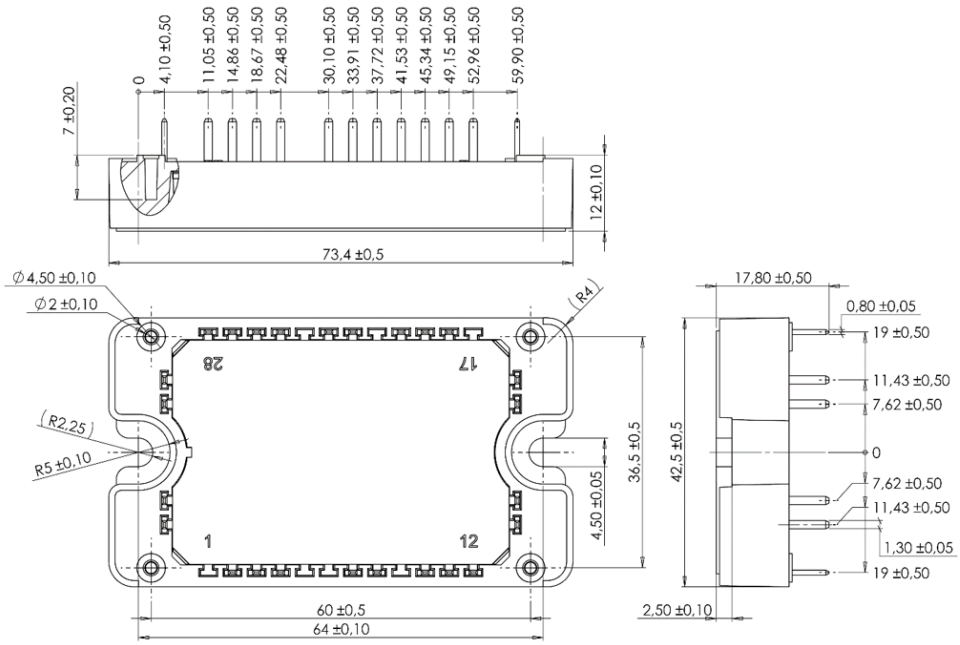
Figure 20 • Capacitance vs. Reverse Voltage



4 Package Specification

This section shows the package outline of the MSCSM70HM19CT3AG device. All dimensions are in millimeters.

Figure 21 • Package Outline



See application note 1906 – Mounting Instructions for SP3F Power Modules on *www.microsemi.com*.

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