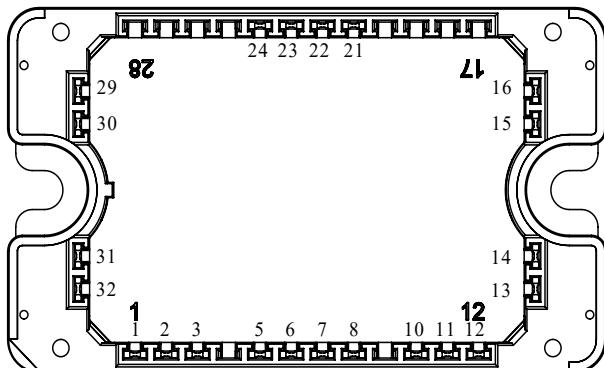
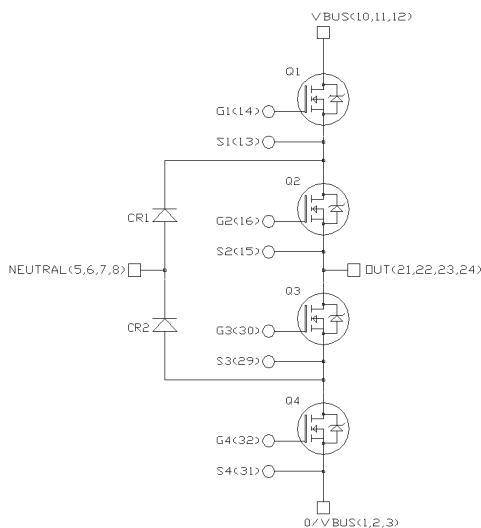


Three Level Inverter SiC MOSFET Power Module

Product Overview

The MSCSM170TLM23C3AG device is a three level inverter 1700V/124A silicon carbide (SiC) MOSFET power module.



Notes:

1. All multiple inputs and outputs must be shorted together. 1/2/3 ; 10/11/12 ; 5/6/7/8 ; 21/22/23/24.
2. All ratings at $T_J = 25^\circ\text{C}$, unless otherwise specified.



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

Features

The following are key features of the MSCSM170TLM23C3AG device:

- SiC Power MOSFET
 - Low $R_{DS(on)}$
 - High temperature performance
- SiC Schottky Diode (CR1 and CR2)
 - Zero reverse recovery
 - Zero forward recovery
 - Temperature independent switching behavior
 - Positive temperature coefficient on VF
- Low stray inductance
- Kelvin source for easy drive
- High level of integration
- Aluminum nitride (AlN) substrate for improved thermal performance

Benefits

The following are the benefits of MSCSM170TLM23C3AG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Solderable terminals for power and signal for easy mounting of PCB mounting
- Low profile
- RoHS Compliant

Application

The MSCSM170TLM23C3AG device is designed for the following applications:

- Uninterruptible power supplies

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM170TLM23C3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170TLM23C3AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings		Unit
V_{DSS}	Drain-Source voltage	1700		V
I_D	Continuous drain current	$T_C = 25^\circ\text{C}$	124	A
		$T_C = 80^\circ\text{C}$	98	
I_{DM}	Pulsed drain current	240		
V_{GS}	Gate-Source voltage	-10/23		V
$R_{DS(on)}$	Drain-Source ON resistance	22.5		$\text{m}\Omega$
P_D	Power dissipation	$T_C = 25^\circ\text{C}$	602	W

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170TLM23C3AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{V}$; $V_{DS} = 1700\text{V}$		—	20	200	μA
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20\text{V}$		$T_J = 25^\circ\text{C}$	17.5	22.5	$\text{m}\Omega$
		$I_D = 60\text{A}$		$T_J = 175^\circ\text{C}$	31	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$; $I_D = 5\text{ mA}$		1.8	3.2	—	V
I_{GSS}	Gate-Source leakage current	$V_{GS} = 20\text{V}$; $V_{DS} = 0\text{V}$		—	—	200	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170TLM23C3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{GS} = 0V$ $V_{DS} = 1000V$ $f = 1 MHz$		—	6600	—	pF
C_{oss}	Output capacitance			—	300	—	
C_{rss}	Reverse transfer capacitance			—	20	—	
Q_g	Total gate charge	$V_{GS} = -5V/20V$ $V_{Bus} = 850V$ $I_D = 60A$		—	356	—	nC
Q_{gs}	Gate-source charge			—	98	—	
Q_{gd}	Gate-drain charge			—	54	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$ $V_{Bus} = 900V$ $I_D = 100A$ $R_{G(on)} = 2.4\Omega$ $R_{G(off)} = 1.4\Omega$	$T_J = 150\text{ }^{\circ}\text{C}$	—	24	—	ns
T_r	Rise time			—	17	—	
$T_{d(off)}$	Turn-off delay time			—	35	—	
T_f	Fall time			—	19	—	
E_{on}	Turn-on energy	$V_{GS} = -5V/20V$ $V_{Bus} = 900V$ $I_D = 100A$ $R_{G(on)} = 2.4\Omega$ $R_{G(off)} = 1.4\Omega$	$T_J = 150\text{ }^{\circ}\text{C}$	—	2.2	—	mJ
E_{off}	Turn-off energy			—	0.33	—	
R_{Gint}	Internal gate resistance			—	2.93	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.25	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170TLM23C3AG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$V_{GS} = 0V; I_{SD} = 60A$		—	3.7	—	V
		$V_{GS} = -5V; I_{SD} = 60A$		—	3.9	—	
t_{rr}	Reverse recovery time	$I_{SD} = 60A; V_{GS} = -5V$ $V_R = 900V; di_F/dt = 2000 A/\mu s$		—	27	—	ns
Q_{rr}	Reverse recovery charge			—	1300	—	
I_{rr}	Reverse recovery current			—	92	—	

1.2

CR1 and CR2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the CR1 and CR2 SiC diode ratings and characteristics per SiC diode of MSCSM170TLM23C3AG device.

Table 1-5. SiC Schottky Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	1700	V
I_{RRM}	Reverse leakage current	$V_R = 1700V$	$T_J = 25^\circ C$	—	20	400	μA
			$T_J = 175^\circ C$	—	300	—	
I_F	DC forward current	—	$T_C = 125^\circ C$	—	60	—	A
V_F	Diode forward voltage	$I_F = 60A$	$T_J = 25^\circ C$	—	1.5	1.8	V
			$T_J = 175^\circ C$	—	2.3	—	
Q_C	Total capacitive charge	$V_R = 900V$		—	460	—	nC
C	Total capacitance	$f = 1 \text{ MHz}, V_R = 600V$		—	334	—	pF
		$f = 1 \text{ MHz}, V_R = 900V$		—	276	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.276	°C/W

1.3

Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170TLM23C3AG device.

Table 1-6. 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
Wt	Package weight	—	110	g

1.4

Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM170TLM23C3AG device.

Figure 1-1. Maximum Thermal Impedance

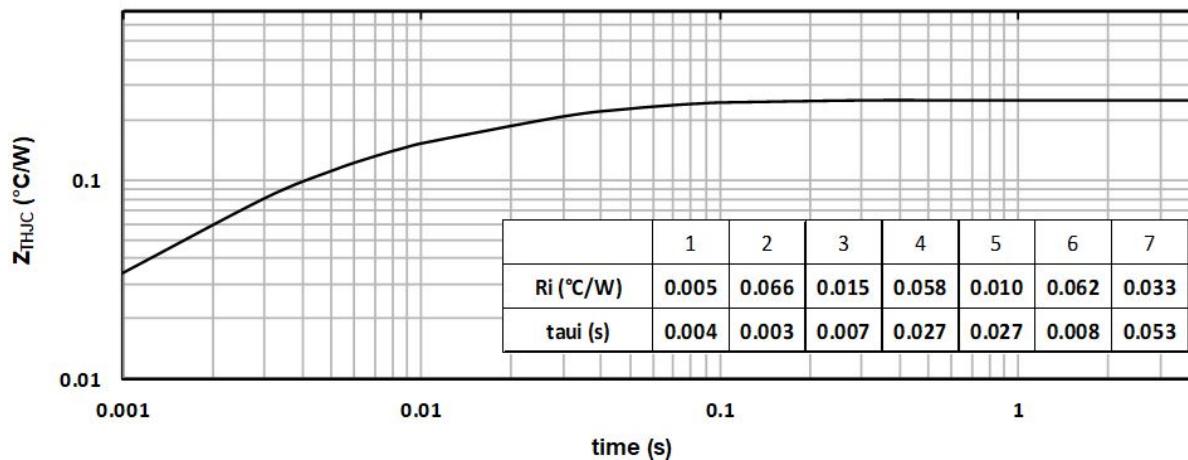


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

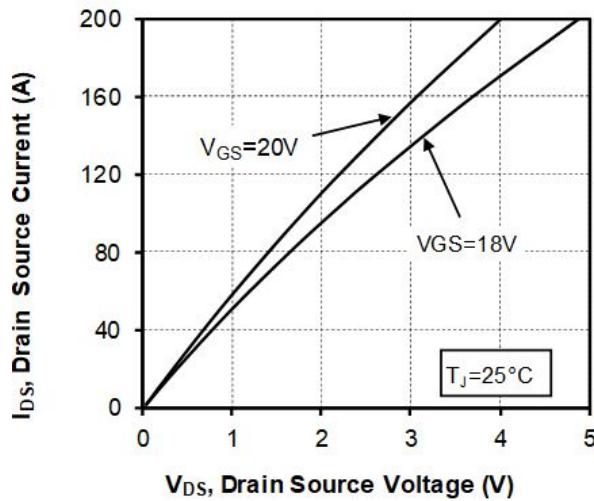


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

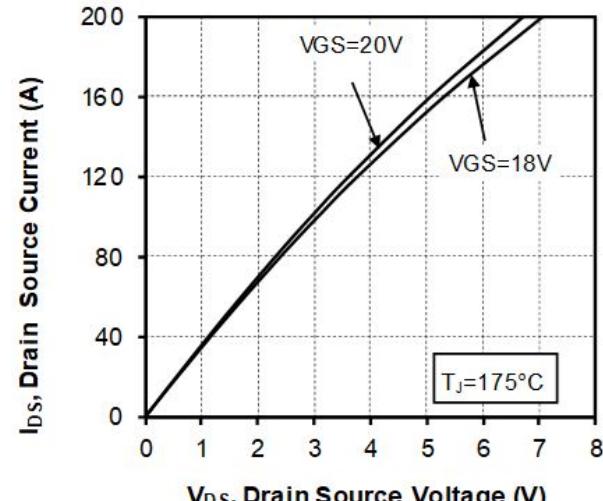


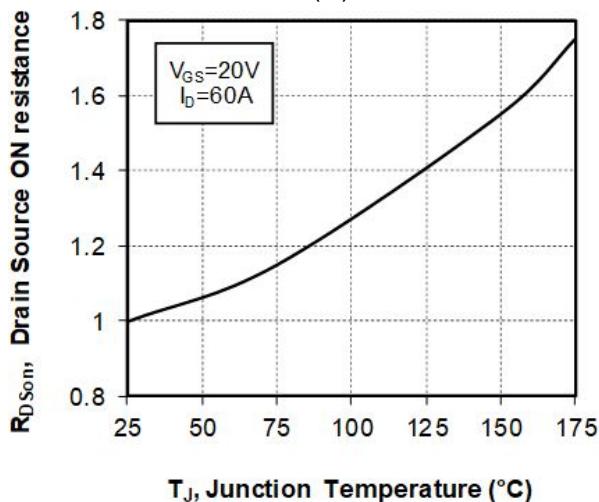
Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

Figure 1-5. Transfer Characteristics

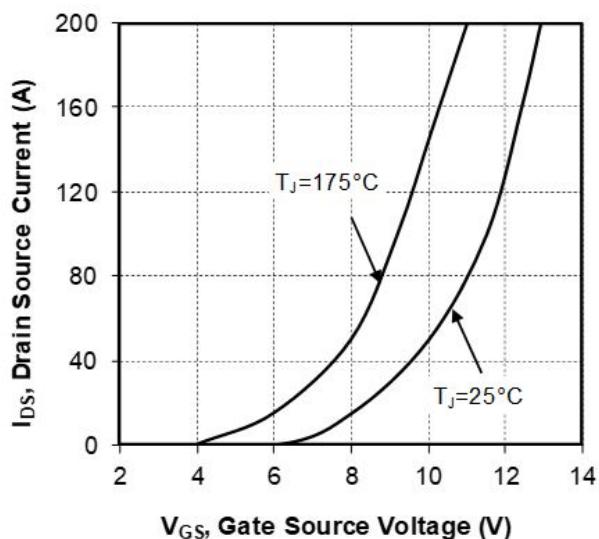
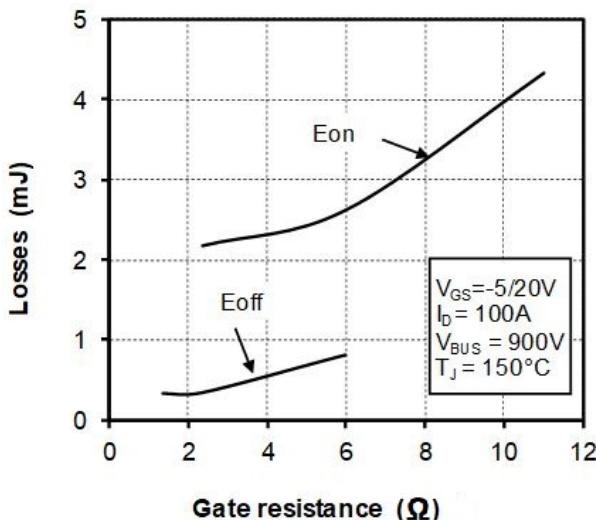
Figure 1-6. Switching Energy vs. R_g 

Figure 1-7. Switching Energy vs. Current

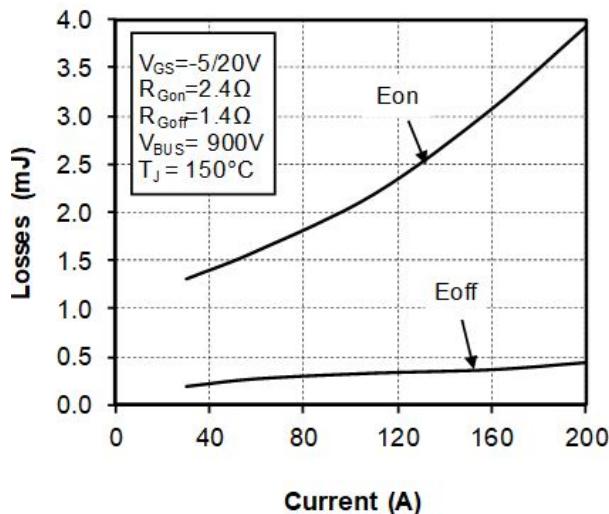


Figure 1-8. Capacitance vs. Drain Source Voltage

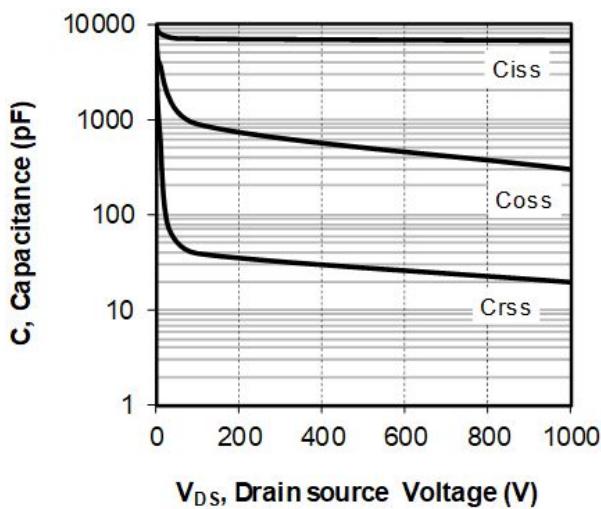


Figure 1-9. Gate Charge vs. Gate Source Voltage

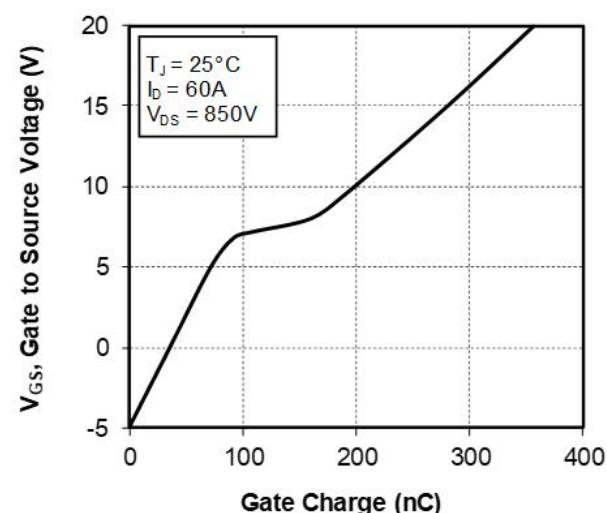
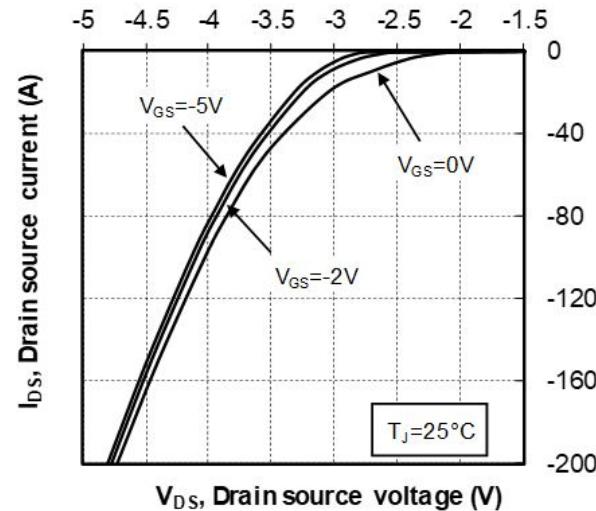
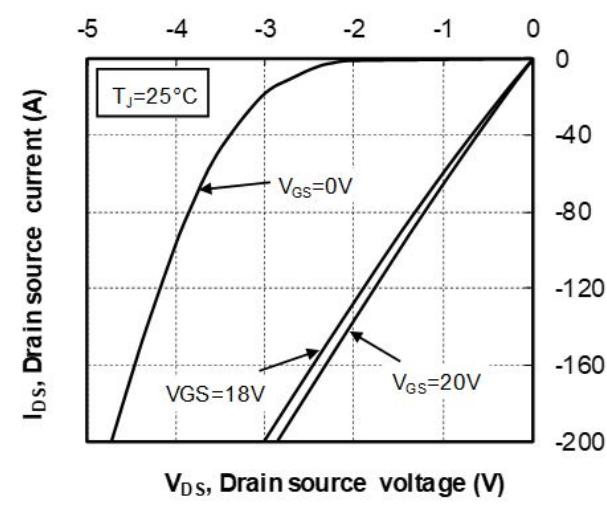
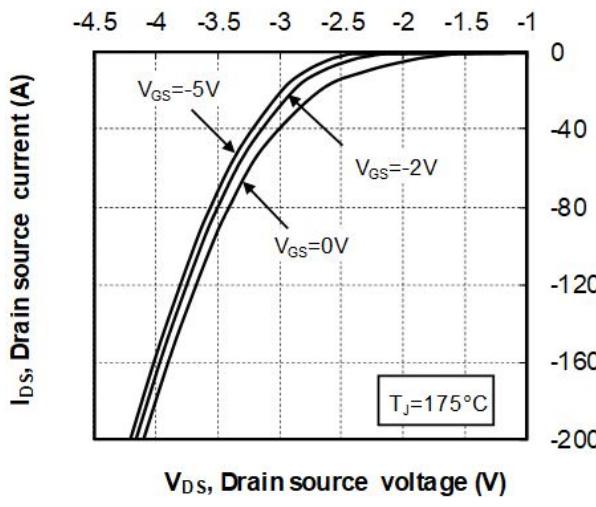
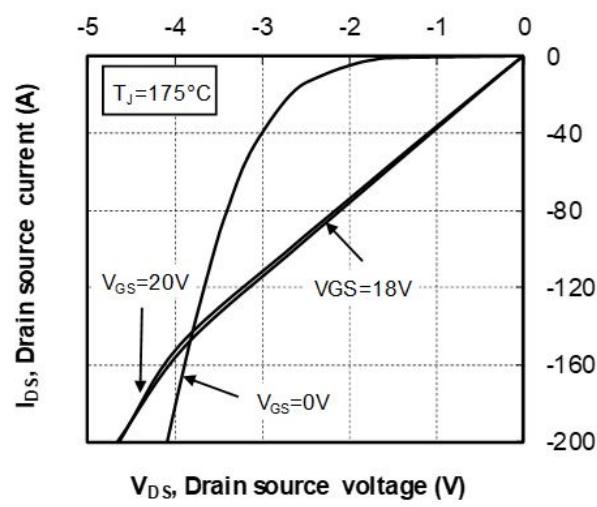
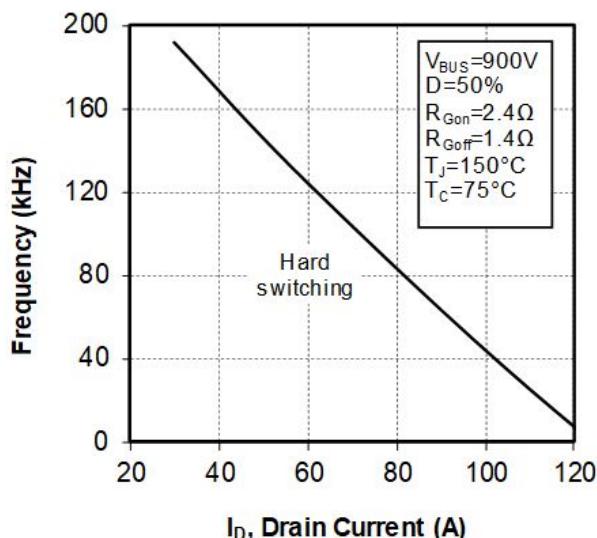
Figure 1-10. Body Diode Characteristics, $T_J = 25^\circ\text{C}$ Figure 1-11. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$ Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$ Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$ 

Figure 1-14. Operating Frequency vs Drain Current



1.5

Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM170TLM23C3AG device.

Figure 1-15. Maximum Thermal Impedance

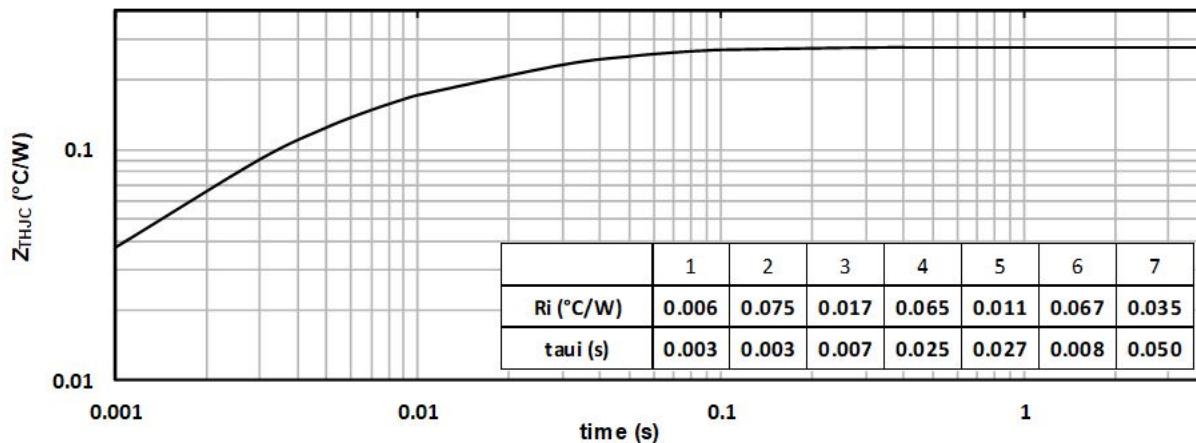


Figure 1-16. Forward Characteristics

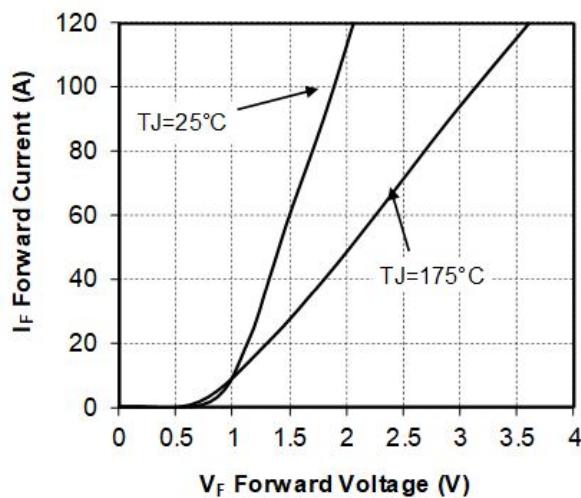
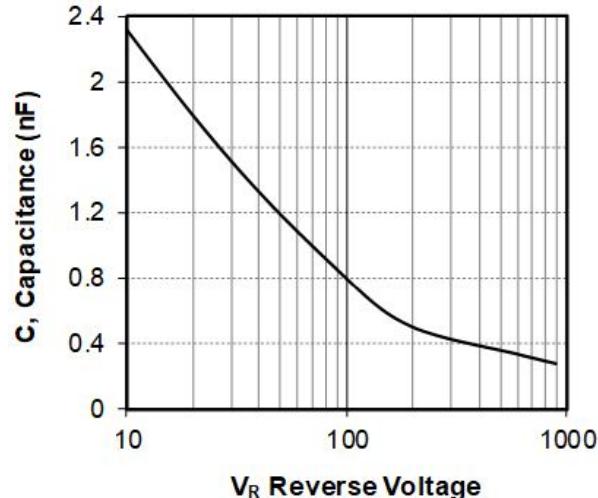


Figure 1-17. Capacitance vs. Reverse Voltage



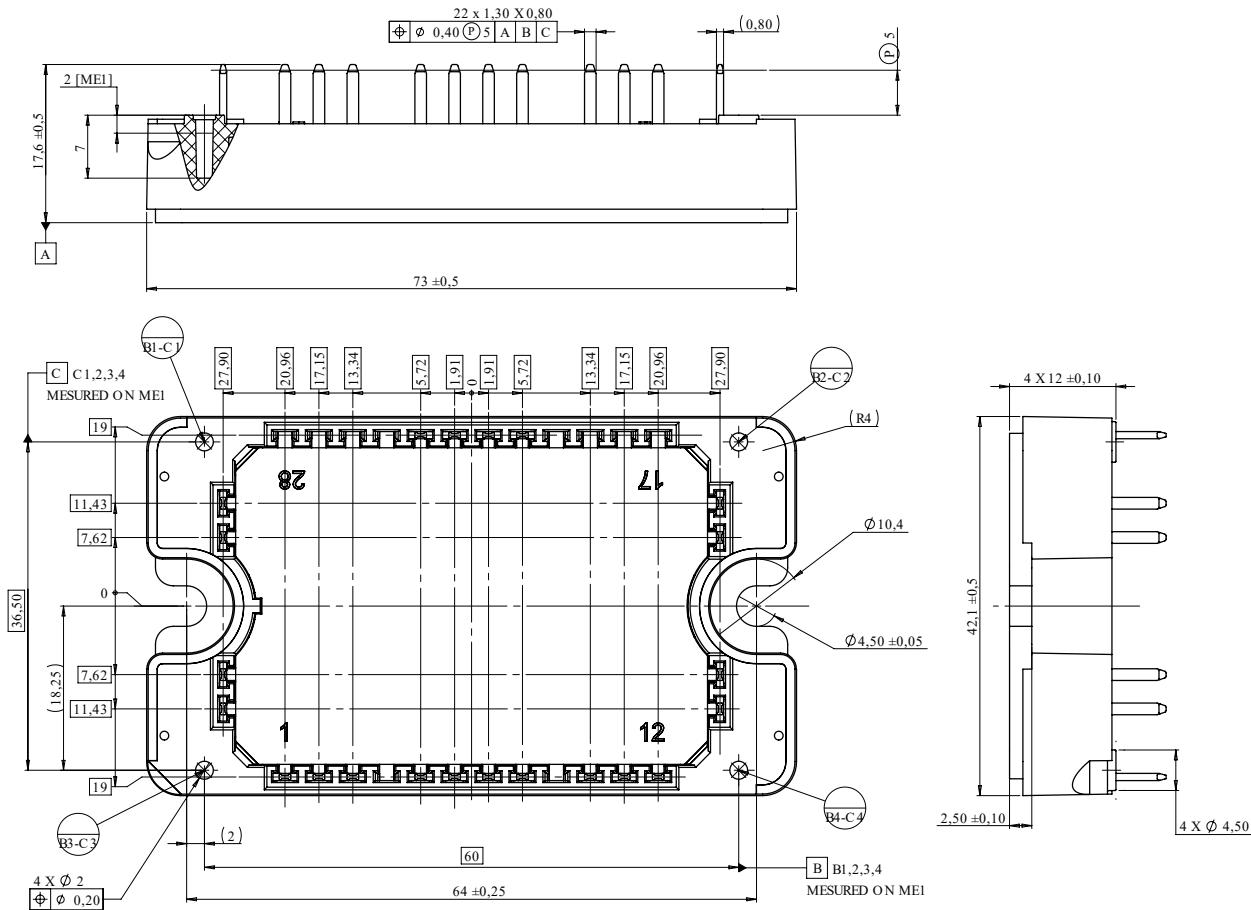
2. Package Specifications

The following section shows the package specification of the MSCSM170TLM23C3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170TLM23C3AG 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	12/2021	This is the first publication of this document.

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