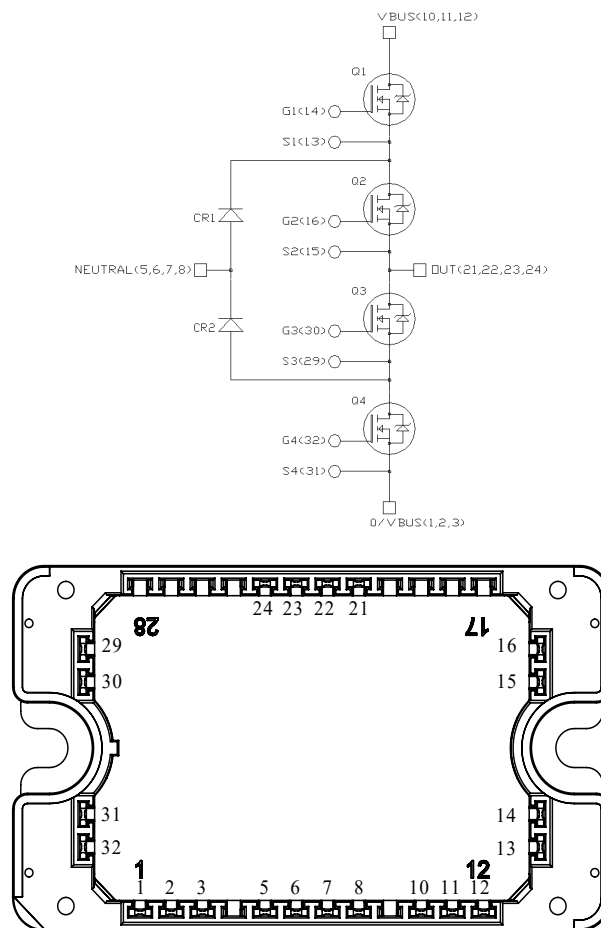


## Three Level Inverter SiC MOSFET Power Module

### 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
$V_{DS}$	Drain-Source voltage		1700	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	124	A
		$T_C = 80\text{ }^{\circ}\text{C}$	98	
$I_{DM}$	Pulsed drain current		240	
$V_{GS}$	Gate-Source voltage		-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		22.5	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	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	$V_{GS} = 0V$ ; $V_{DS} = 1700V$		—	20	200	$\mu A$
$R_{DS(on)}$	Drain-Source on resistance	$V_{GS} = 20V$ $I_D = 60A$	$T_J = 25\text{ }^{\circ}\text{C}$	—	17.5	22.5	m $\Omega$
			$T_J = 175\text{ }^{\circ}\text{C}$	—	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	$V_{GS} = 20V$ ; $V_{DS} = 0V$		—	—	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	$V_{GS} = 0V$		—	6600	—	pF
$C_{oss}$	Output capacitance	$V_{DS} = 1000V$		—	300	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$		—	20	—	
$Q_g$	Total gate charge	$V_{GS} = -5V/20V$		—	356	—	nC
$Q_{gs}$	Gate-source charge	$V_{Bus} = 850V$		—	98	—	
$Q_{gd}$	Gate-drain charge	$I_D = 60A$		—	54	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^{\circ}C$	—	24	—	ns
$T_r$	Rise time	$V_{Bus} = 900V$		—	17	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 100A$		—	35	—	
$T_f$	Fall time	$R_{G(on)} = 2.4\Omega$ $R_{G(off)} = 1.4\Omega$		—	19	—	
$E_{on}$	Turn-on energy	$V_{GS} = -5V/20V$	$T_J = 150\text{ }^{\circ}C$	—	2.2	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 900V$ $I_D = 100A$ $R_{G(on)} = 2.4\Omega$ $R_{G(off)} = 1.4\Omega$	$T_J = 150\text{ }^{\circ}C$	—	0.33	—	
$R_{Gint}$	Internal gate resistance			—	2.93	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance			—	—	0.25	$^{\circ}C/W$

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	$I_{SD} = 60A; V_{GS} = -5V$	—	27	—	ns
$Q_{rr}$	Reverse recovery charge	$V_R = 900V; di_F/dt = 2000\text{ A}/\mu s$	—	1300	—	nC
$I_{rr}$	Reverse recovery current		—	92	—	A

### 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	$V_R = 1700V$	$T_J = 25\text{ }^{\circ}C$	—	20	400	$\mu A$
			$T_J = 175\text{ }^{\circ}C$	—	300	—	
$I_F$	DC forward current	—	$T_C = 125\text{ }^{\circ}C$	—	60	—	A
$V_F$	Diode forward voltage	$I_F = 60A$	$T_J = 25\text{ }^{\circ}C$	—	1.5	1.8	V
			$T_J = 175\text{ }^{\circ}C$	—	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	$^{\circ}C/W$

### 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 $t = 1\text{ min}$ , 50 Hz/60 Hz			4000	—	V
$T_J$	Operating junction temperature range			−40	175	$^{\circ}C$
$T_{JOP}$	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

### 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

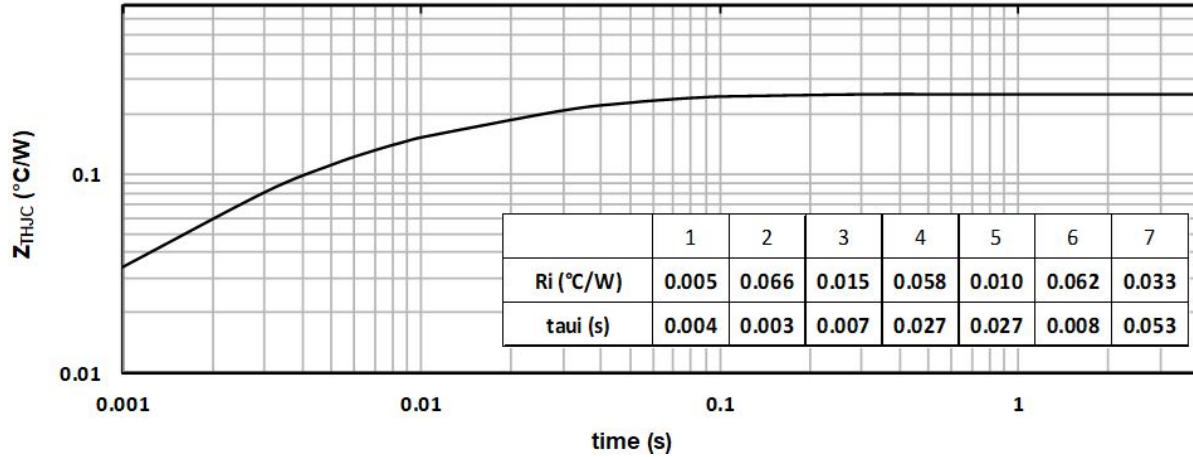


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

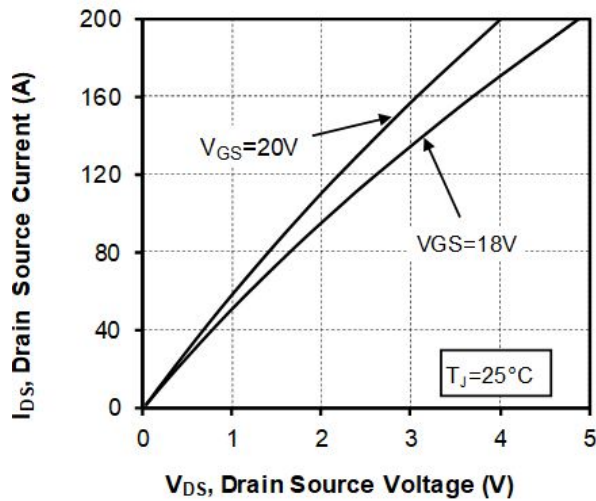


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

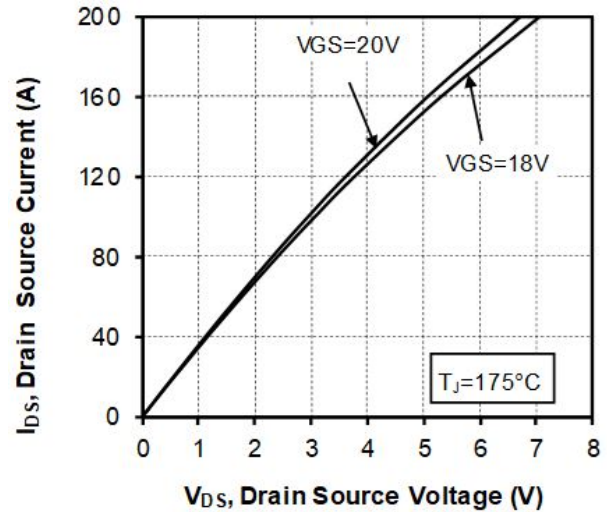


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

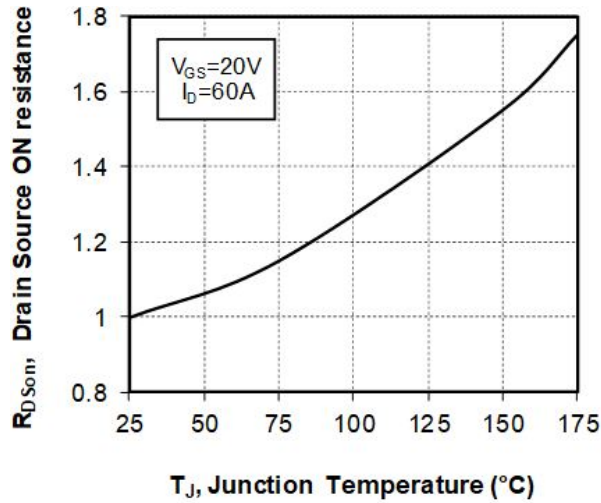


Figure 1-5. Transfer Characteristics

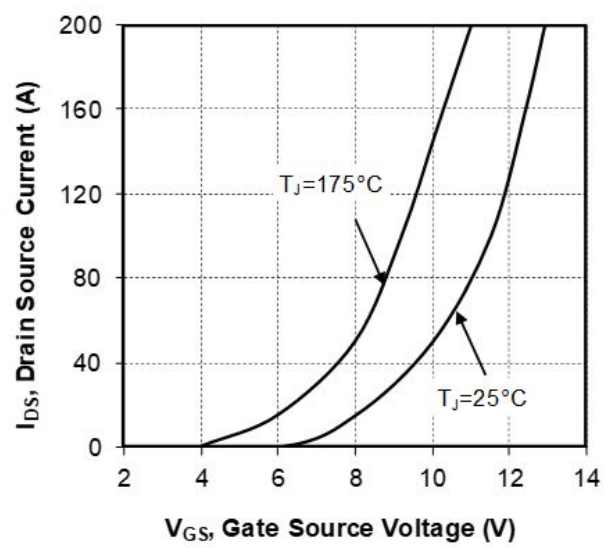


Figure 1-6. Switching Energy vs.  $R_g$

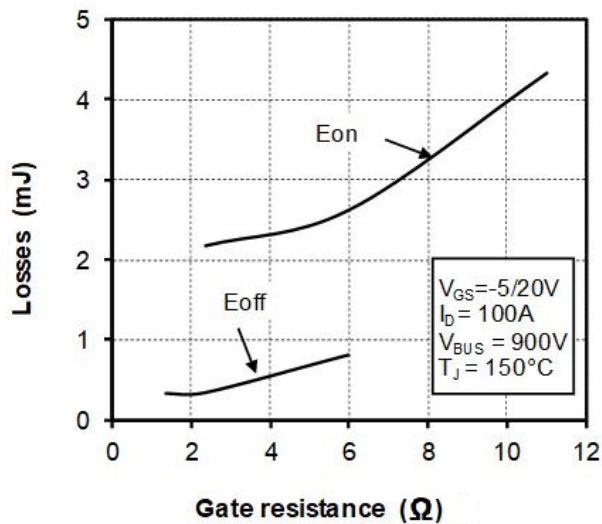


Figure 1-7. Switching Energy vs. Current

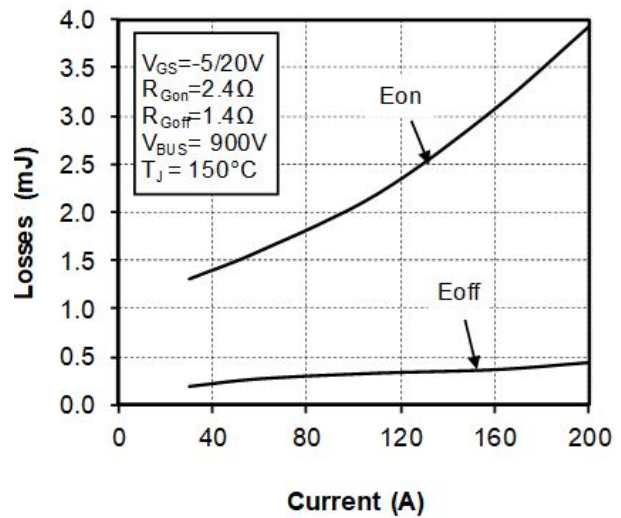




Figure 1-8. Capacitance vs. Drain Source Voltage

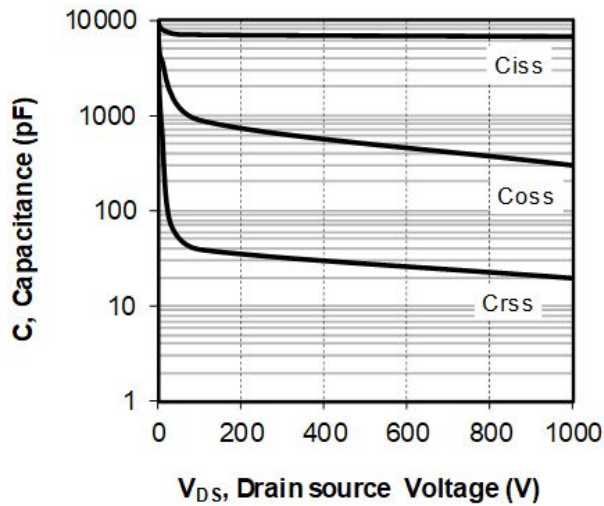


Figure 1-9. Gate Charge vs. Gate Source Voltage

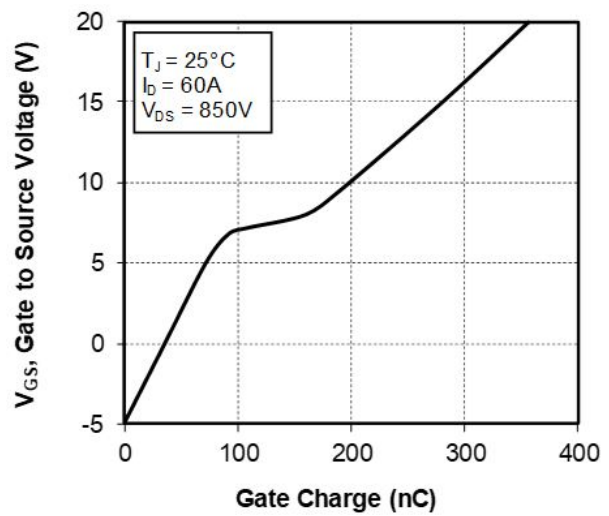


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

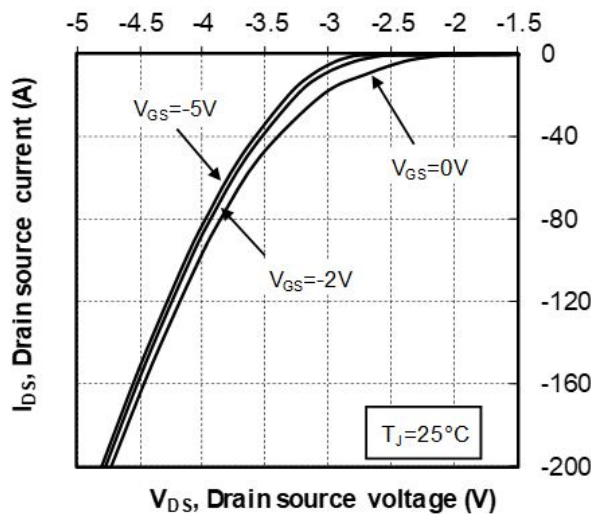


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

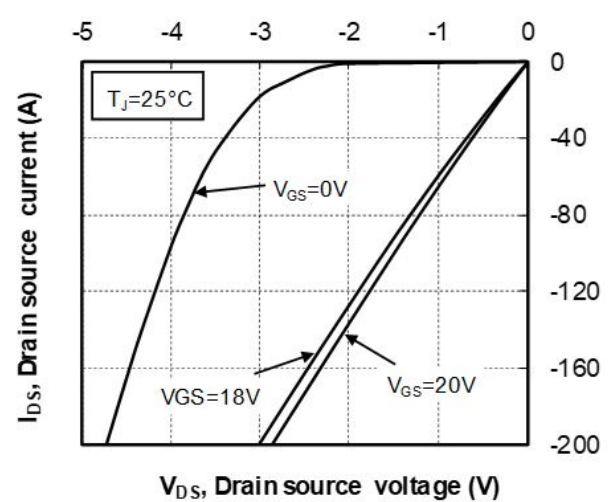


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

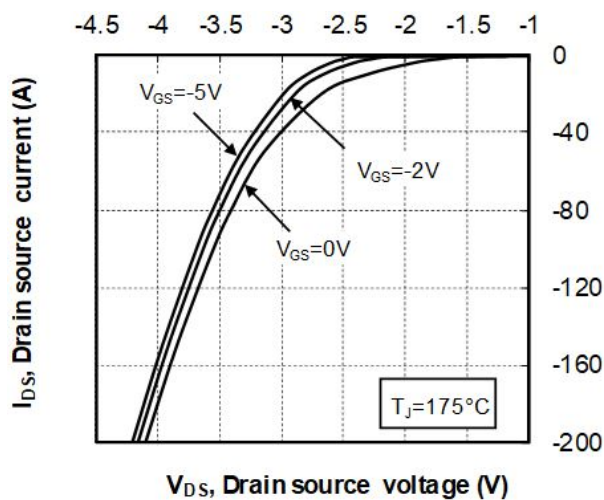


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

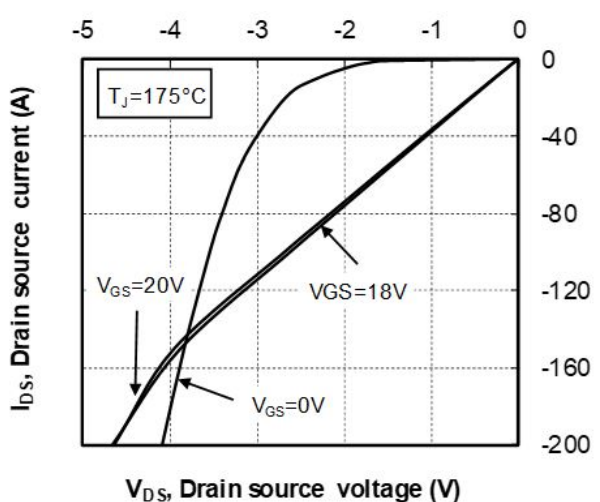
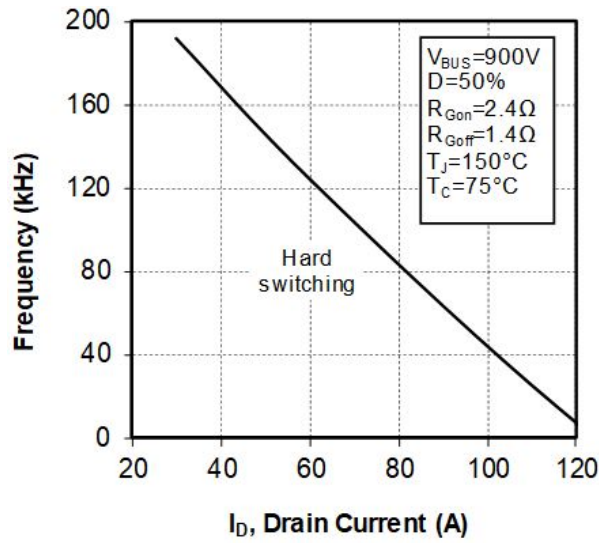




Figure 1-14. Operating Frequency vs Drain Current



### 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

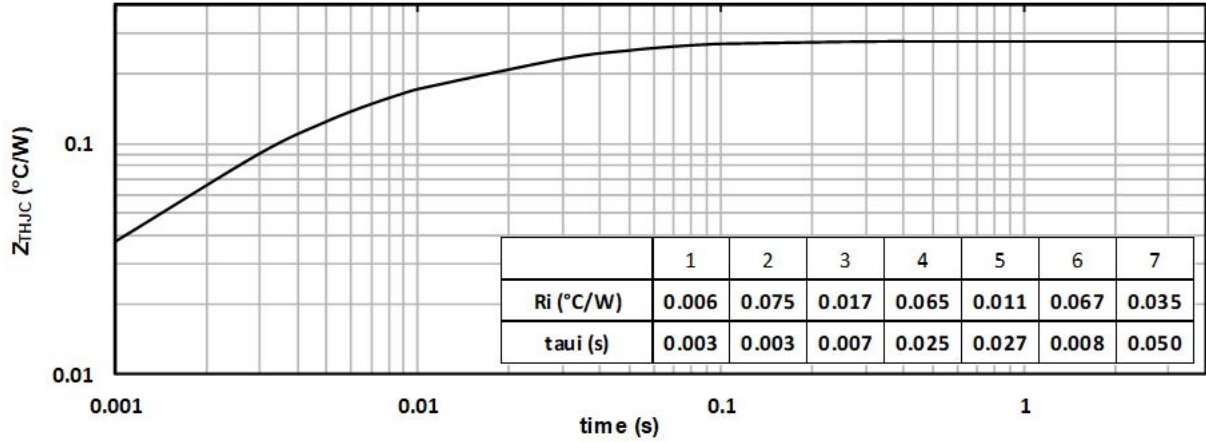


Figure 1-16. Forward Characteristics

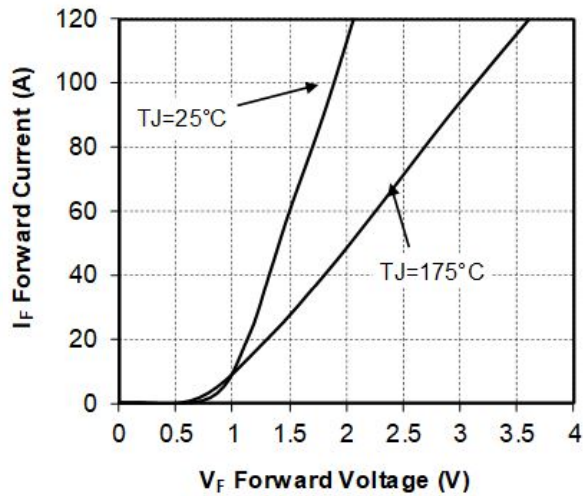
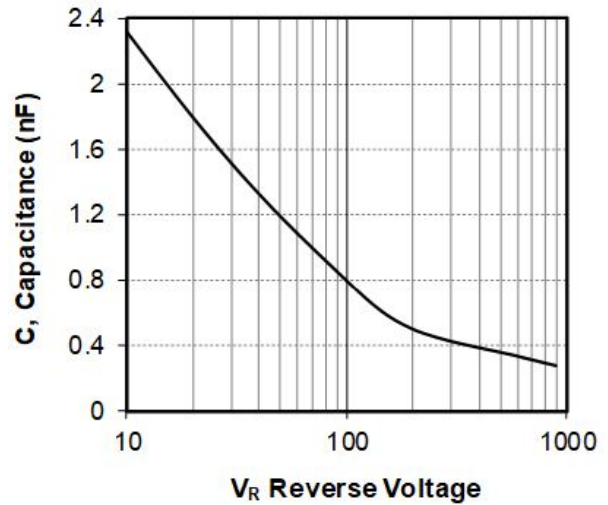


Figure 1-17. Capacitance vs. Reverse Voltage



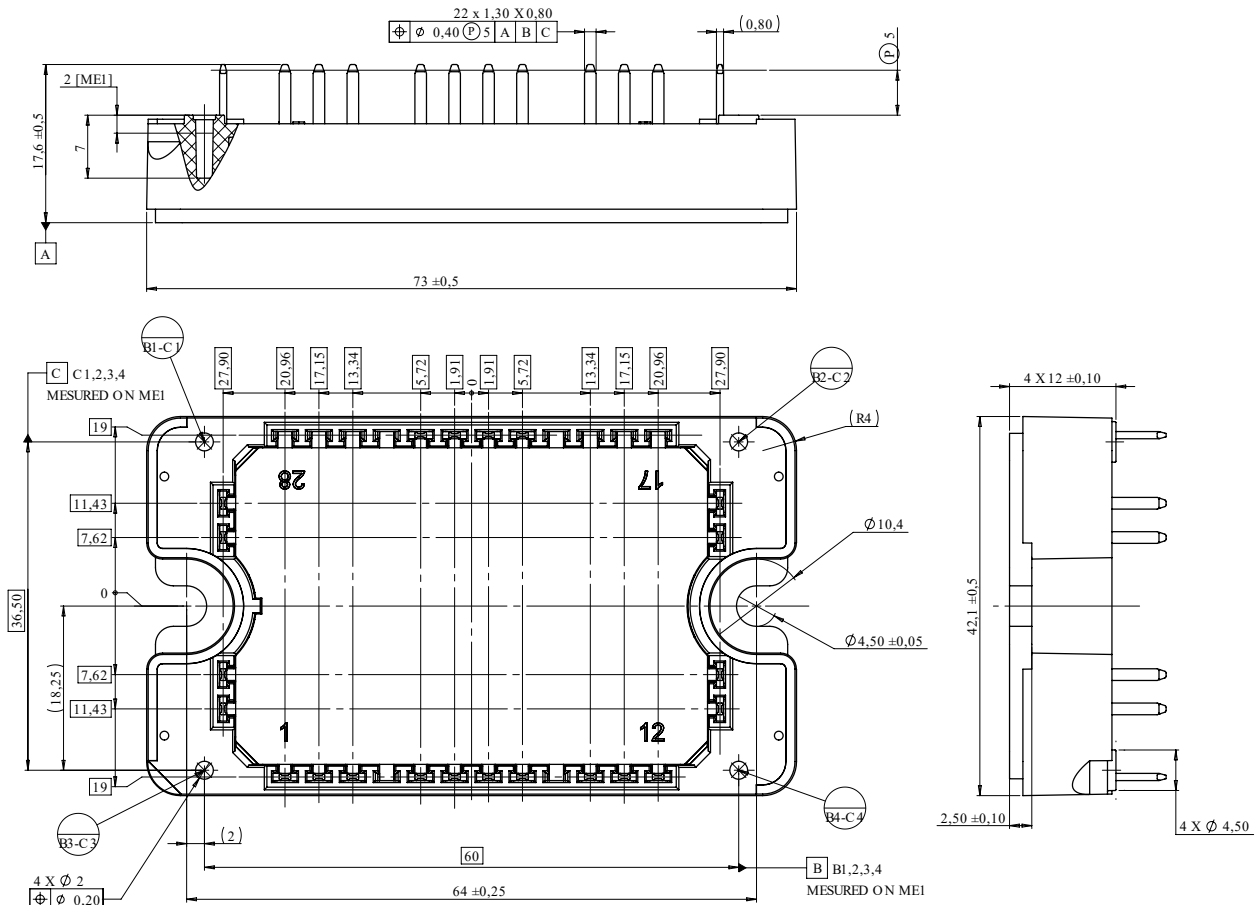
## 2. Package Specifications

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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