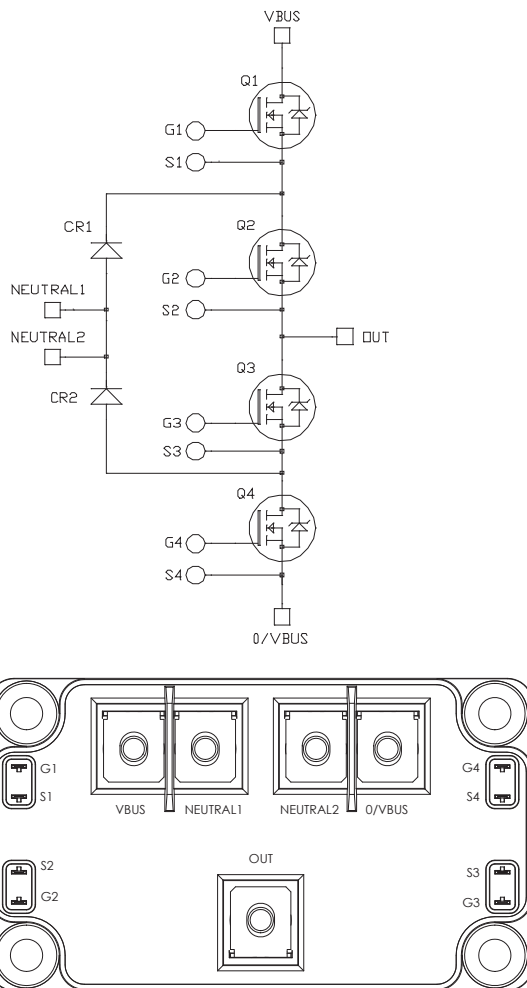


Three Level Inverter SiC MOSFET Power Module

Product Overview

The MSCSM70TLM05CAG device is a 700V/464A, three level inverter silicon carbide (SiC) MOSFET power module.



All ratings at $T_j = 25\text{ }^\circ\text{C}$, unless otherwise specified.



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

Features

The following are the key features of MSCSM70TLM05CAG device:

- SiC Power MOSFET
 - Low $R_{DS(on)}$
 - High temperature performance
- SiC Schottky Diode
 - Zero reverse recovery
 - Zero forward recovery
 - Temperature independent switching behavior
 - Positive temperature coefficient on V_F
- Kelvin source for easy drive
- Low stray inductance
- High level of integration
- Aluminum Nitride (AlN) substrate for improved thermal performance
- M5 power connectors

Benefits

The following are the benefits of MSCSM70TLM05CAG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS compliant

Application

The following are the applications of MSCSM70TLM05CAG device:

- Solar converter
- Uninterruptible power supplies

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM70TLM05CAG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70TLM05CAG device.

Table 1-1. Absolute Maximum Ratings

| Symbol | Parameter | Maximum Ratings | Unit |
|--------------|----------------------------|----------------------------------|------------|
| V_{DSS} | Drain-Source voltage | 700 | V |
| I_D | Continuous drain current | $T_C = 25\text{ }^\circ\text{C}$ | 464 |
| | | $T_C = 80\text{ }^\circ\text{C}$ | 369 |
| I_{DM} | Pulsed drain current | 900 | |
| V_{GS} | Gate-Source voltage | -10/25 | V |
| $R_{DS(on)}$ | Drain-Source ON resistance | 4.8 | m Ω |
| P_D | Power dissipation | $T_C = 25\text{ }^\circ\text{C}$ | 1277 |

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM70TLM05CAG device.

Table 1-2. Electrical Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------------------|---|-----------------------------------|------|------|---------------|
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0V$ $V_{DS} = 700V$ | — | — | 400 | μA |
| $R_{DS(on)}$ | Drain-Source on resistance | $V_{GS} = 20V$ $I_D = 160A$ | $T_J = 25\text{ }^\circ\text{C}$ | — | 3.8 | 4.8 |
| | | | $T_J = 175\text{ }^\circ\text{C}$ | — | 4.8 | — |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS} = V_{DS}$ $I_D = 16\text{ mA}$ | 1.9 | 2.4 | — | V |
| I_{GSS} | Gate-Source leakage current | $V_{GS} = 20V$ $V_{DS} = 0V$ | — | — | 400 | nA |

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The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70TLM05CAG device.

Table 1-3. Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit | |
|--------------|-------------------------------------|---|-----------------------------------|------|-------|--------------------|----|
| C_{iss} | Input capacitance | $V_{GS} = 0V$ | — | 18 | — | nF | |
| C_{oss} | Output capacitance | $V_{DS} = 700V$ | — | 2 | — | | |
| C_{rss} | Reverse transfer capacitance | $f = 1\text{ MHz}$ | — | 0.11 | — | | |
| Q_g | Total gate charge | $V_{GS} = -5V/20V$ | — | 860 | — | nC | |
| Q_{gs} | Gate-source charge | $V_{Bus} = 470V$ | — | 232 | — | | |
| Q_{gd} | Gate-drain charge | $I_D = 160A$ | — | 140 | — | | |
| $T_{d(on)}$ | Turn-on delay time | $V_{GS} = -5V/20V$ | $T_J = 150\text{ }^\circ\text{C}$ | — | 78 | — | ns |
| T_r | Rise time | $V_{Bus} = 400V$ | | — | 125 | — | |
| $T_{d(off)}$ | Turn-off delay time | $I_D = 320A$ | | — | 214 | — | |
| T_f | Fall time | $R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$ | | — | 92 | — | |
| E_{on} | Turn-on energy | $V_{GS} = -5V/20V$ | $T_J = 150\text{ }^\circ\text{C}$ | — | 4.1 | — | mJ |
| E_{off} | Turn-off energy | $V_{Bus} = 400V$ $I_D = 320A$ $R_{G(on)} = 7\Omega$ $R_{G(off)} = 4\Omega$ | $T_J = 150\text{ }^\circ\text{C}$ | — | 7 | — | |
| R_{Gint} | Internal gate resistance | | — | 1.4 | — | Ω | |
| R_{thJC} | Junction-to-case thermal resistance | | — | — | 0.117 | $^\circ\text{C/W}$ | |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM70TLM05CAG device.

Table 1-4. Body Diode Ratings and Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|----------|--------------------------|---|------|------|------|---------------|
| V_{SD} | Diode forward voltage | $V_{GS} = 0V$ $I_{SD} = 160A$ | — | 3.4 | — | V |
| | | $V_{GS} = -5V$ $I_{SD} = 160A$ | — | 3.8 | — | |
| t_{rr} | Reverse recovery time | $I_{SD} = 160A$ | — | 40 | — | ns |
| Q_{rr} | Reverse recovery charge | $V_{GS} = -5V$ | — | 2 | — | μC |
| I_{rr} | Reverse recovery current | $V_R = 400V$ $di_F/dt = 4000A/\mu\text{s}$ | — | 76 | — | 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 the MSCSM70TLM05CAG device.

Table 1-5. 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 | $V_R = 700V$ | $T_J = 25\text{ }^\circ\text{C}$ | — | 90 | 1200 | μA |
| | | | $T_J = 175\text{ }^\circ\text{C}$ | — | 1500 | — | |
| I_F | DC forward current | $T_C = 65\text{ }^\circ\text{C}$ | | — | 300 | — | A |
| V_F | Diode forward voltage | $I_F = 300A$ | $T_J = 25\text{ }^\circ\text{C}$ | — | 1.5 | 1.8 | V |
| | | | $T_J = 175\text{ }^\circ\text{C}$ | — | 1.9 | — | |
| Q_C | Total capacitive charge | $V_R = 400V$ | | — | 798 | — | nC |
| C | Total capacitance | $f = 1\text{ MHz}$ $V_R = 200V$ | | — | 1488 | — | pF |
| | | $f = 1\text{ MHz}$ $V_R = 400V$ | | — | 1296 | — | |
| R_{thJC} | Junction-to-case thermal resistance | | | — | — | 0.167 | $^\circ\text{C/W}$ |

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM70TLM05CAG device.

Table 1-6. Thermal and Package Characteristics

| Symbol | Characteristic | | 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 | $^\circ\text{C}$ | |
| T_{JOP} | Recommended junction temperature under switching conditions | | −40 | $T_{Jmax} - 25$ | | |
| T_{STG} | Storage case temperature | | −40 | 125 | | |
| T_C | Operating case temperature | | −40 | 125 | | |
| Torque | Mounting torque | To heatsink | M6 | 3 | | 5 |
| | | For terminals | M5 | 2 | 3.5 | |
| Wt | Package weight | | — | 300 | g | |

1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70TLM05CAG device.

Figure 1-1. Maximum Thermal Impedance

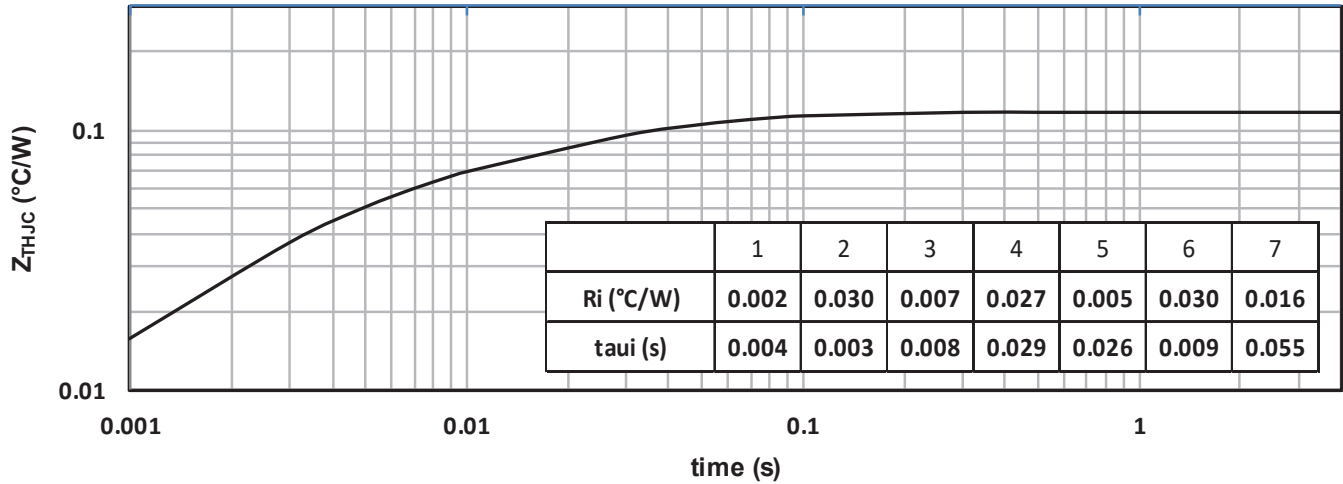


Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$

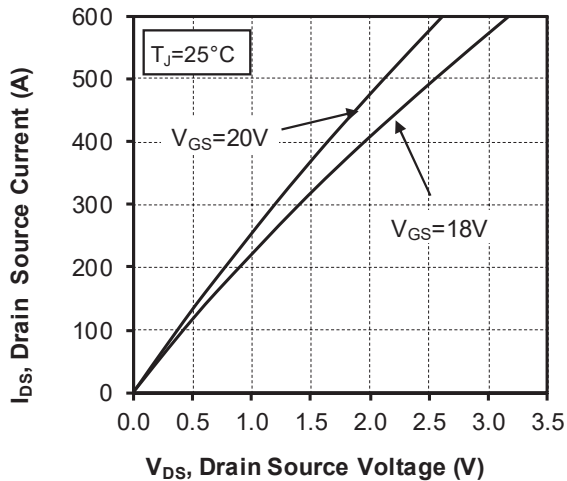


Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$

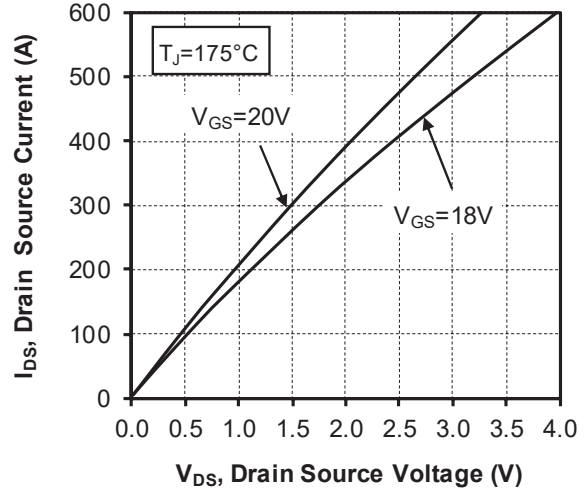


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

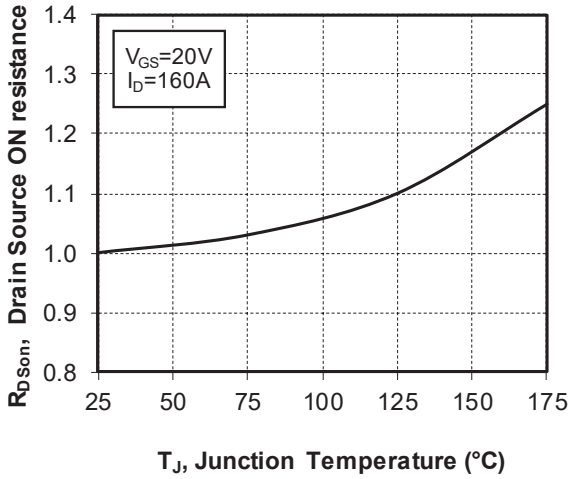


Figure 1-5. Transfer Characteristics

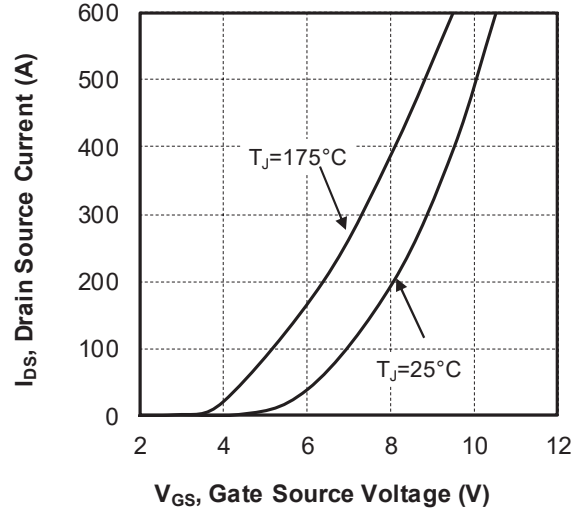


Figure 1-6. Capacitance vs. Drain Source Voltage

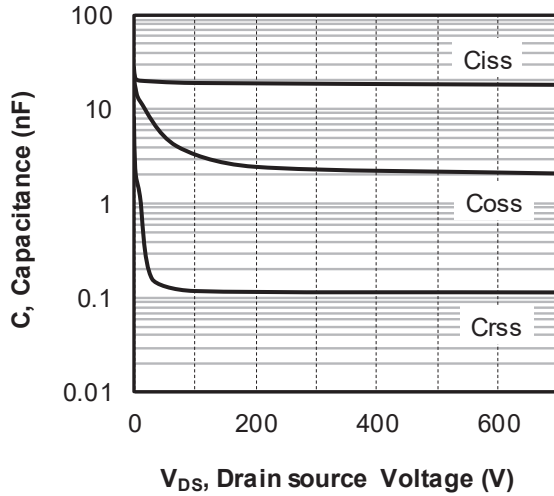


Figure 1-7. Gate Charge vs. Gate Source Voltage

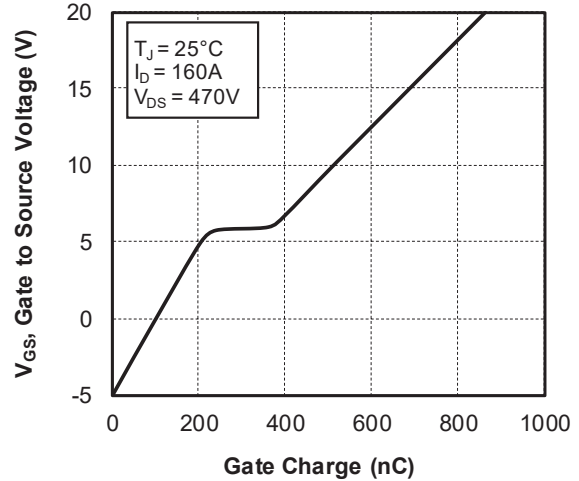


Figure 1-8. Body Diode Characteristics, $T_J = 25^\circ\text{C}$

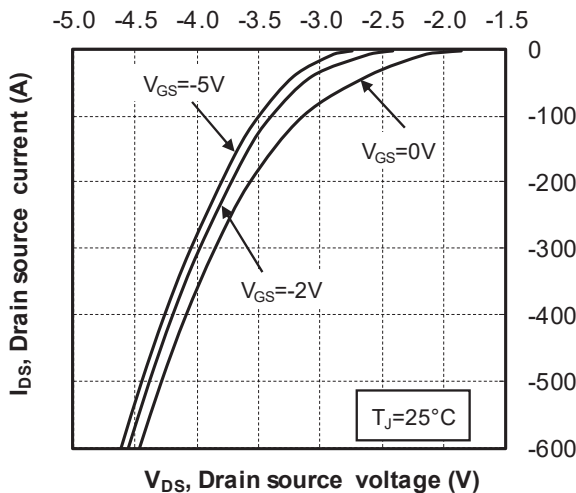
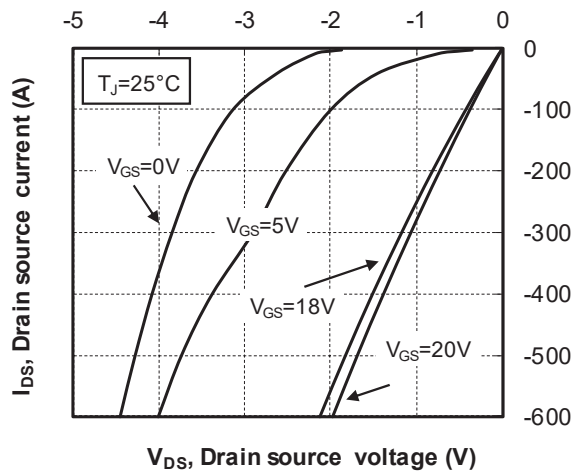


Figure 1-9. 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$



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Figure 1-10. Body Diode Characteristics, $T_J = 175^\circ\text{C}$

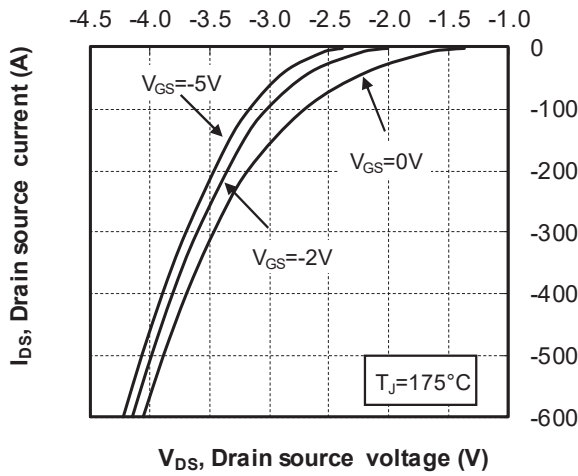


Figure 1-11. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

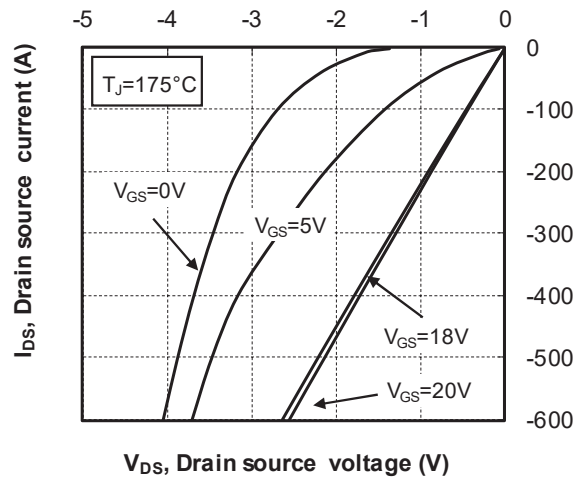


Figure 1-12. Turn On Energy vs. R_g

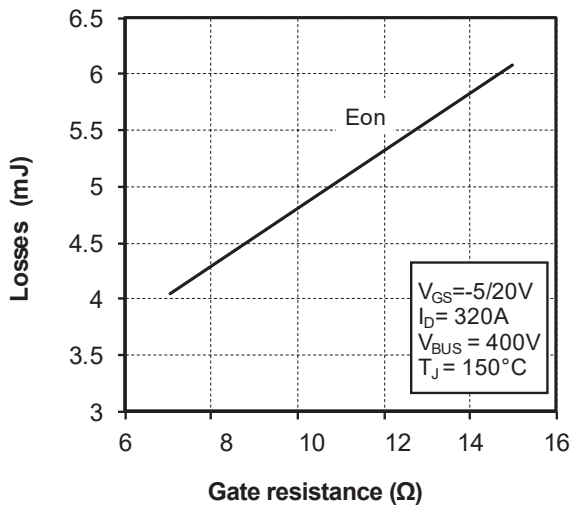


Figure 1-13. Turn Off Energy vs. R_g

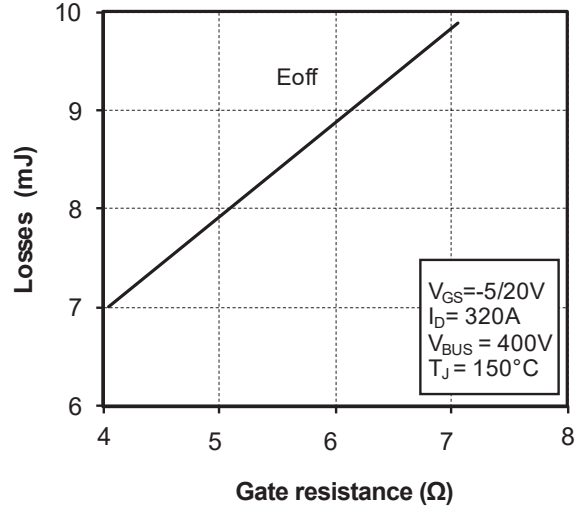


Figure 1-14. Switching Energy vs. Current

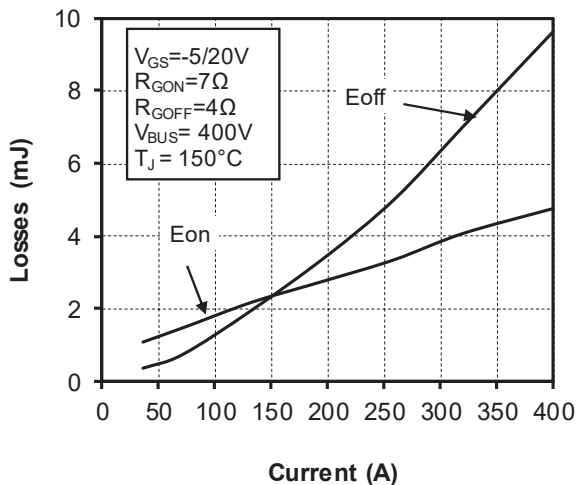
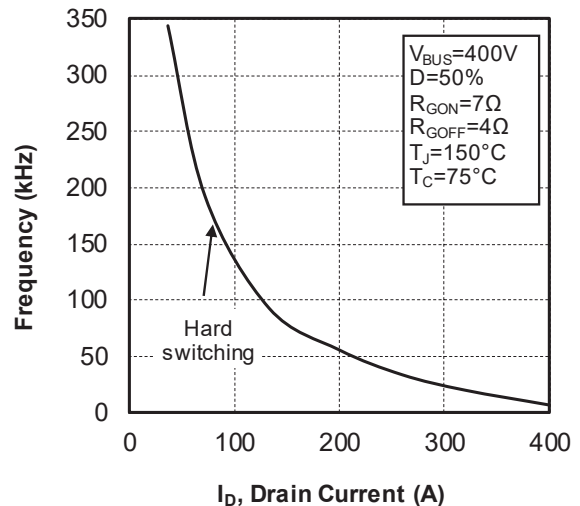


Figure 1-15. Operating Frequency vs. Drain Current



1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM70TLM05CAG device.

Figure 1-16. Maximum Thermal Impedance

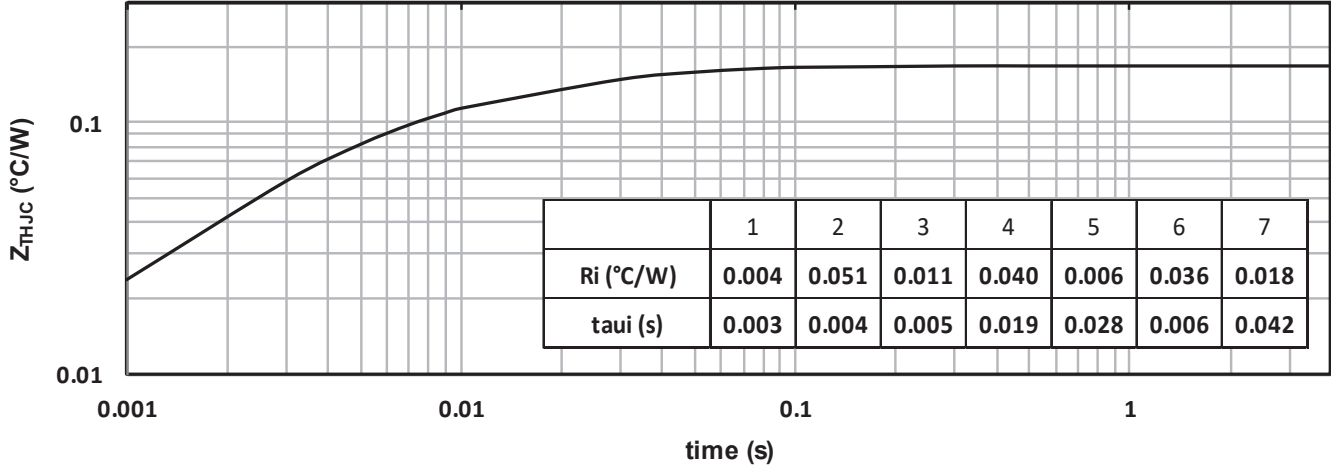


Figure 1-17. Forward Characteristics

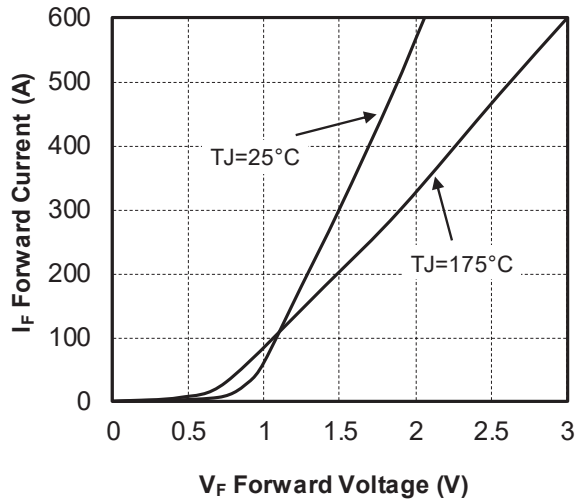
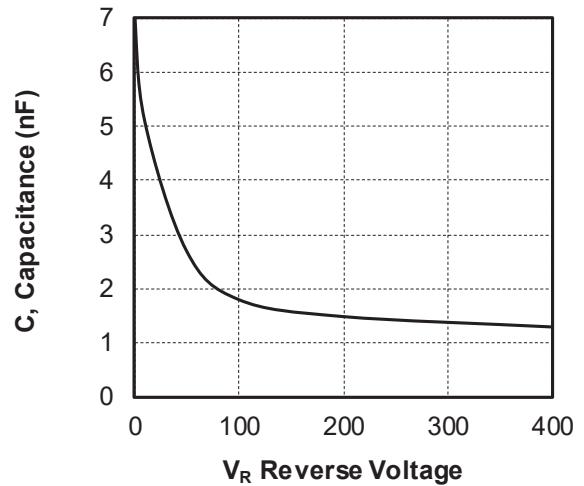


Figure 1-18. Capacitance vs. Reverse Voltage



3. Revision History

| Revision | Date | Description |
|----------|---------|-------------------|
| A | 12/2021 | Initial Revision. |

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