

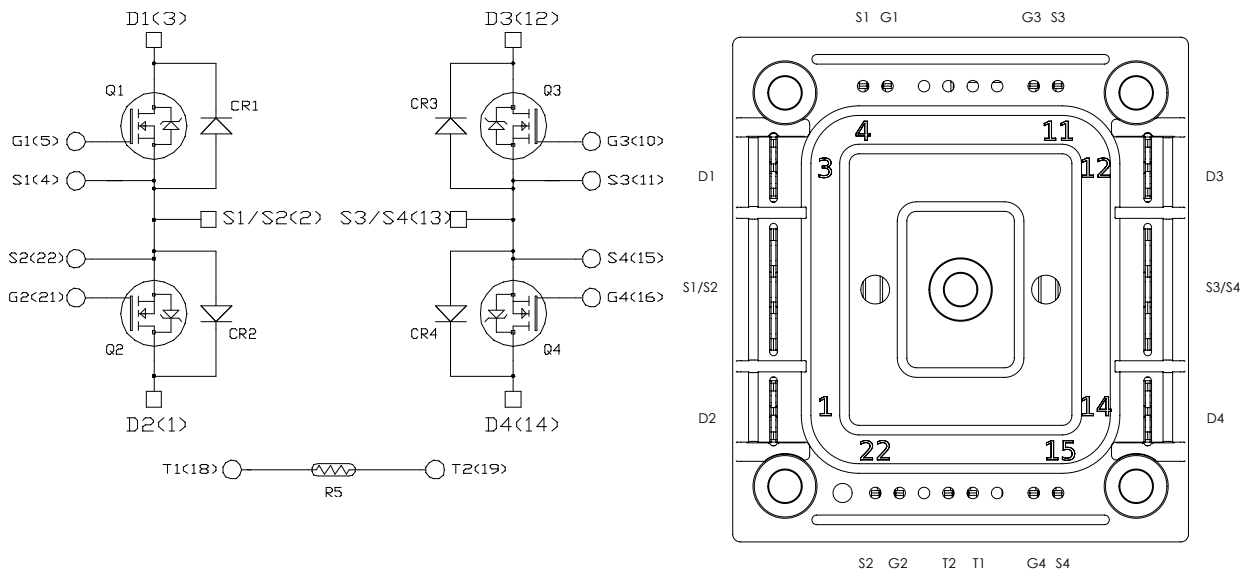
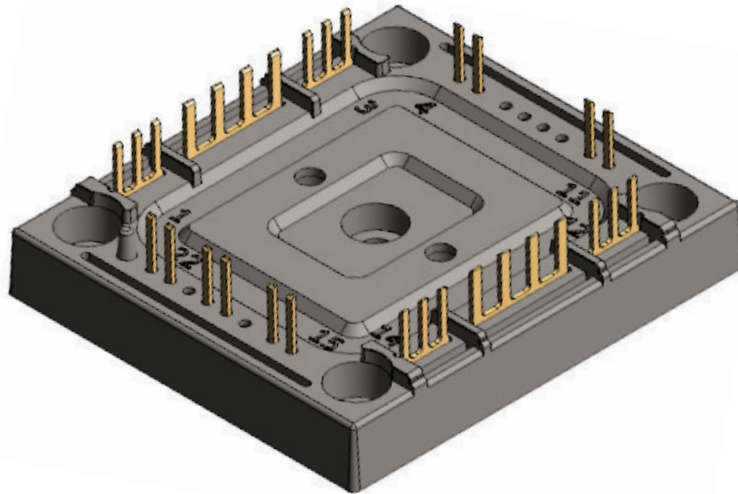


# MICROCHIP MSCSM120DDUM16CTBL3NG

## Double Dual Common Source SiC MOSFET Power Module

### Product Overview

The MSCSM120DDUM16CTBL3NG device is a double dual common source 1200 V/150 A silicon carbide (SiC) MOSFET power module.



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

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

## Features

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The following are the key features of MSCSM120DDUM16CTBL3NG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High speed switching
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF
- Ultra-low weight and profile
- Kelvin source for easy drive
- $Si_3N_4$  substrate with thick copper for improved thermal performance
- Internal thermistor for temperature monitoring
- Extended temperature range

## Benefits

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The following are the benefits of MSCSM120DDUM16CTBL3NG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS compliant
- Solderable terminals both for power and signal for easy PCB mounting
- Very integrated power conversion system

## Application

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The following are the applications of MSCSM120DDUM16CTBL3NG device:

- High reliability power systems
- AC switches

### 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120DDUM16CTBL3NG device.

#### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of MSCSM120DDUM16CTBL3NG device.

**Table 1-1. Absolute Maximum Ratings**

| Symbol       | Parameter                  | Maximum Ratings                  | Unit      |
|--------------|----------------------------|----------------------------------|-----------|
| $V_{DSS}$    | Drain-Source voltage       | 1200                             | V         |
| $I_D$        | Continuous drain current   | $T_H = 25\text{ }^\circ\text{C}$ | 150       |
|              |                            | $T_H = 80\text{ }^\circ\text{C}$ | 120       |
| $I_{DM}$     | Pulsed drain current       | 300                              |           |
| $V_{GS}$     | Gate-Source voltage        | -10/25                           | V         |
| $R_{DS(on)}$ | Drain-Source ON resistance | 16                               | $m\Omega$ |
| $P_D$        | Power dissipation          | $T_H = 25\text{ }^\circ\text{C}$ | 560       |

The following table lists the electrical characteristics of MSCSM120DDUM16CTBL3NG device.

**Table 1-2. Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                               | Min                               | Typ | Max  | Unit          |           |
|--------------|---------------------------------|---|-----------------------------------|-----|------|---------------|-----------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0\text{ V}; V_{DS} = 1200\text{ V}$ | —                                 | 20  | 200  | $\mu\text{A}$ |           |
| $R_{DS(on)}$ | Drain-Source on resistance      | $V_{GS} = 20\text{ V}$<br>$I_D = 80\text{ A}$ | $T_J = 25\text{ }^\circ\text{C}$  | —   | 12.5 | 16            | $m\Omega$ |
|              |                                 |   | $T_J = 175\text{ }^\circ\text{C}$ | —   | 20   | —             |           |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}; I_D = 2\text{ mA}$          | 1.8                               | 2.8 | —    | 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 of MSCSM120DDUM16CTBL3NG device.

**Table 1-3. Dynamic Characteristics**

| Symbol       | Characteristic                          | Test Conditions   | Min                               | Typ   | Max | Unit               |
|--------------|---|---|-----------------------------------|-------|-----|--------------------|
| $C_{iss}$    | Input capacitance                       | $V_{GS} = 0\text{ V}$   | —                                 | 6040  | —   | pF                 |
| $C_{oss}$    | Output capacitance                      | $V_{DS} = 1000\text{ V}$<br>$f = 1\text{ MHz}$  | —                                 | 540   | —   |                    |
| $C_{rss}$    | Reverse transfer capacitance            |   | —                                 | 50    | —   |                    |
| $Q_g$        | Total gate charge                       | $V_{GS} = -5\text{ V}/20\text{ V}$  | —                                 | 464   | —   | nC                 |
| $Q_{gs}$     | Gate-Source charge                      | $V_{Bus} = 800\text{ V}$<br>$I_D = 80\text{ A}$   | —                                 | 82    | —   |                    |
| $Q_{gd}$     | Gate-Drain charge                       |   | —                                 | 100   | —   |                    |
| $T_{d(on)}$  | Turn-on delay time                      | $V_{GS} = -5\text{ V}/20\text{ V}$  | —                                 | 30    | —   | ns                 |
| $T_r$        | Rise time                               | $V_{Bus} = 600\text{ V}$  | —                                 | 30    | —   |                    |
| $T_{d(off)}$ | Turn-off delay time                     | $I_D = 100\text{ A}$  | —                                 | 50    | —   |                    |
| $T_f$        | Fall time                               | $R_{Gon} = 4\ \Omega$ ; $R_{Goff} = 2.4\ \Omega$  | —                                 | 25    | —   |                    |
| $E_{on}$     | Turn-on energy                          | $V_{GS} = -5\text{ V}/20\text{ V}$  |                                   | 1.98  | —   | mJ                 |
| $E_{off}$    | Turn-off energy                         | $V_{Bus} = 600\text{ V}$<br>$I_D = 100\text{ A}$<br>$R_{Gon} = 4\ \Omega$<br>$R_{Goff} = 2.4\ \Omega$ | $T_J = 150\text{ }^\circ\text{C}$ | 1.3   | —   |                    |
| $R_{Gint}$   | Internal gate resistance                |   | —                                 | 1.94  | —   | $\Omega$           |
| $R_{thJH}$   | Junction-to-heatsink thermal resistance | $\lambda = 3.4\text{ W/mK}$   | —                                 | 0.268 | —   | $^\circ\text{C/W}$ |

The following table lists the body diode ratings and characteristics of MSCSM120DDUM16CTBL3NG device.

**Table 1-4. Body Diode Ratings and Characteristics**

| Symbol   | Characteristic           | Test Conditions  | Min | Typ  | Max | Unit |
|----------|--------------------------|--|-----|------|-----|------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0\text{ V}$ ; $I_{SD} = 80\text{ A}$               | —   | 4    | —   | V    |
|          |                          | $V_{GS} = -5\text{ V}$ ; $I_{SD} = 80\text{ A}$              | —   | 4.2  | —   |      |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 80\text{ A}$ ; $V_{GS} = -5\text{ V}$              | —   | 90   | —   | ns   |
| $Q_{rr}$ | Reverse recovery charge  | $V_R = 800\text{ V}$ ; $di_F/dt = 2000\text{ A}/\mu\text{s}$ | —   | 1100 | —   | nC   |
| $I_{rr}$ | Reverse recovery current |  | —   | 27   | —   | A    |

### 1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of MSCSM120DDUM16CTBL3NG device.

**Table 1-5. SiC Diode Ratings and Characteristics (Per SiC Diode)**

| Symbol     | Characteristic                          | Test Conditions                        |                       | Min                   | Typ  | Max  | Unit                 |
|------------|---|--|-----------------------|-----------------------|------|------|----------------------|
| $V_{RRM}$  | Peak repetitive reverse voltage         |  |                       | —                     | —    | 1200 | V                    |
| $I_{RRM}$  | Reverse leakage current                 | $V_R = 1200\text{ V}$                  | $T_J = 25\text{ °C}$  | —                     | 20   | 400  | $\mu\text{A}$        |
|            |   |  | $T_J = 175\text{ °C}$ | —                     | 300  | —    |                      |
| $I_F$      | DC forward current                      |  |                       | $T_H = 100\text{ °C}$ | —    | 60   | A                    |
| $V_F$      | Diode forward voltage                   | $I_F = 60\text{ A}$                    | $T_J = 25\text{ °C}$  | —                     | 1.5  | 1.8  | V                    |
|            |   |  | $T_J = 175\text{ °C}$ | —                     | 2.1  | —    |                      |
| $Q_C$      | Total capacitive charge                 | $V_R = 600\text{ V}$                   |                       | —                     | 260  | —    | nC                   |
| C          | Total capacitance                       | $f = 1\text{ MHz}, V_R = 400\text{ V}$ |                       | —                     | 282  | —    | pF                   |
|            |   | $f = 1\text{ MHz}, V_R = 800\text{ V}$ |                       | —                     | 210  | —    |                      |
| $R_{thJH}$ | Junction-to-heatsink thermal resistance | $\lambda_{paste} = 3.4\text{ W/mK}$    |                       | —                     | 0.45 | —    | $^{\circ}\text{C/W}$ |

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of MSCSM120DDUM16CTBL3NG device.

**Table 1-6. Thermal and Package Characteristics**

| Symbol     | Characteristic   |             |    | Min  | Typ  | Max           | Unit               |
|------------|--|-------------|----|------|------|---------------|--------------------|
| $V_{ISOL}$ | RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50 Hz/60 Hz |             |    | 2500 | —    | —             | V                  |
| $T_J$      | Operating junction temperature range   |             |    | -55  | —    | 175           | $^{\circ}\text{C}$ |
| $T_{JOP}$  | Recommended junction temperature under switching conditions                  |             |    | -55  | —    | $T_{Jmax}-25$ |                    |
| $T_{STG}$  | Storage case temperature   |             |    | -55  | —    | 125           |                    |
| $T_C$      | Operating case temperature   |             |    | -55  | —    | 125           |                    |
| Torque     | Mounting torque  | To heatsink | M3 | 0.7  | —    | 0.9           |                    |
| Wt         | Package weight   |             |    | —    | 32.5 | —             | g                  |

The following table lists the temperature sensor NTC of MSCSM120DDUM16CTBL3NG device.

**Table 1-7. Temperature Sensor NTC**

| Symbol                            | Characteristic             | Min                     | Typ  | Max | Unit |
|-----------------------------------|----------------------------|-------------------------|------|-----|------|
| R <sub>25</sub>                   | Resistance at 25 °C        | —                       | 50   | —   | kΩ   |
| ΔR <sub>25</sub> /R <sub>25</sub> | —                          | —                       | 5    | —   | %    |
| B <sub>25/85</sub>                | T <sub>25</sub> = 298.15 K | —                       | 3952 | —   | K    |
| ΔB/B                              | —                          | T <sub>C</sub> = 100 °C | 4    | —   | %    |

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

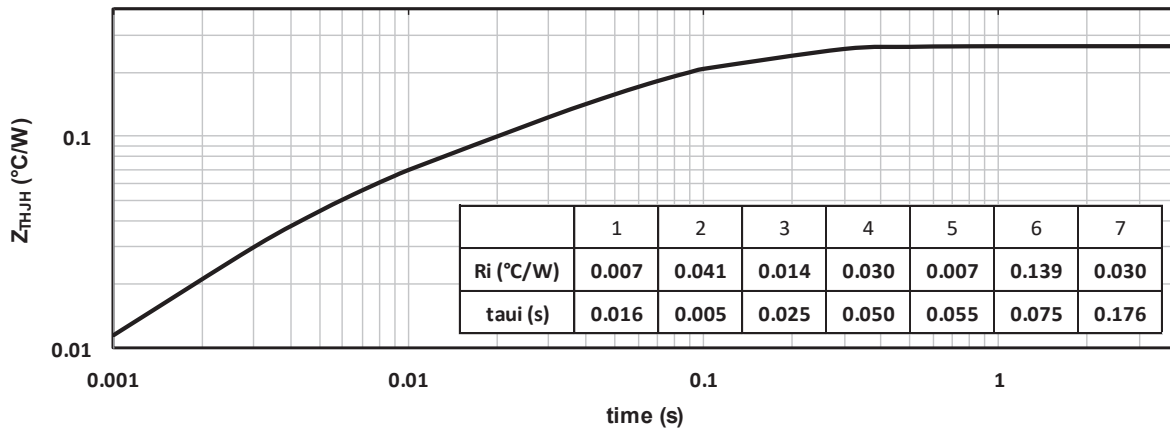
T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

**Note:** See [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#) for more information.

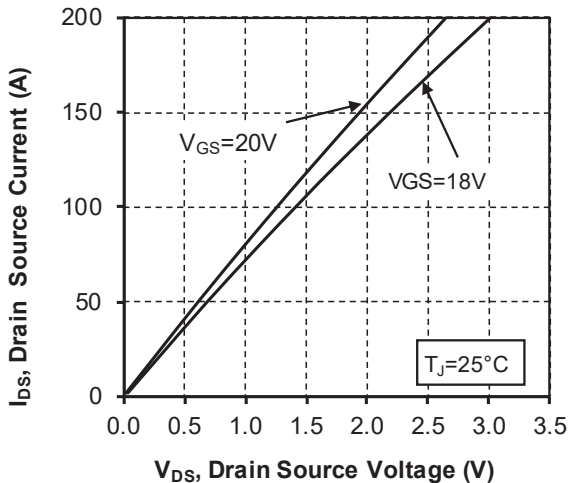
## 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of MSCSM120DDUM16CTBL3NG device.

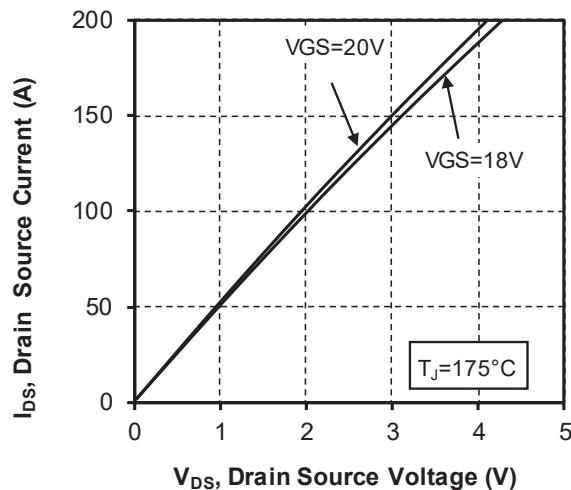
**Figure 1-1. Junction-to-Heatsink Thermal Impedance**



**Figure 1-2. Output Characteristics, T<sub>J</sub> = 25 °C**



**Figure 1-3. Output Characteristics, T<sub>J</sub> = 175 °C**



# MSCSM120DDUM16CTBL3NG

## Electrical Specifications

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

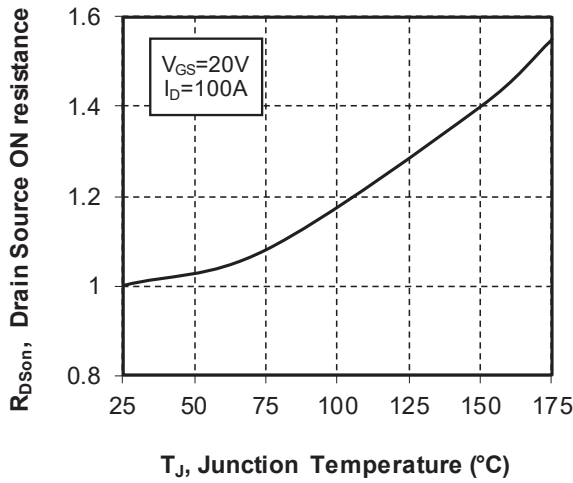


Figure 1-5. Transfer Characteristics

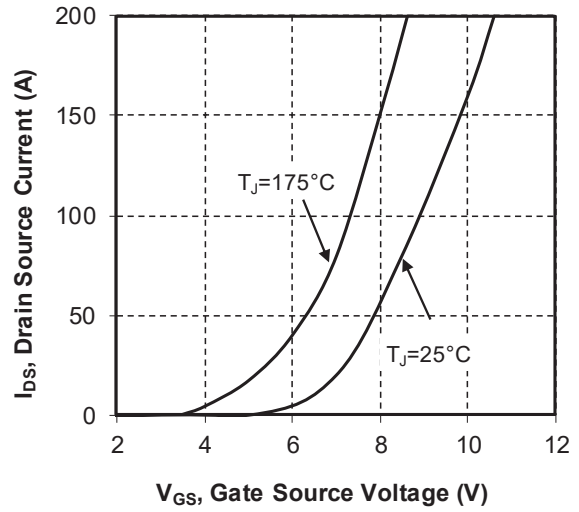


Figure 1-6. Switching Energy vs.  $R_g$

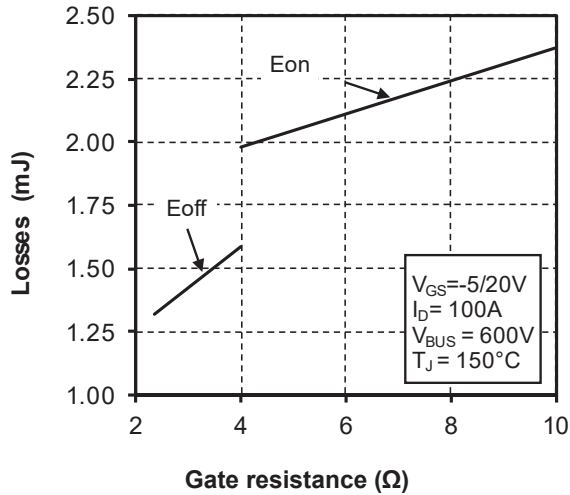


Figure 1-7. Switching Energy vs. Current

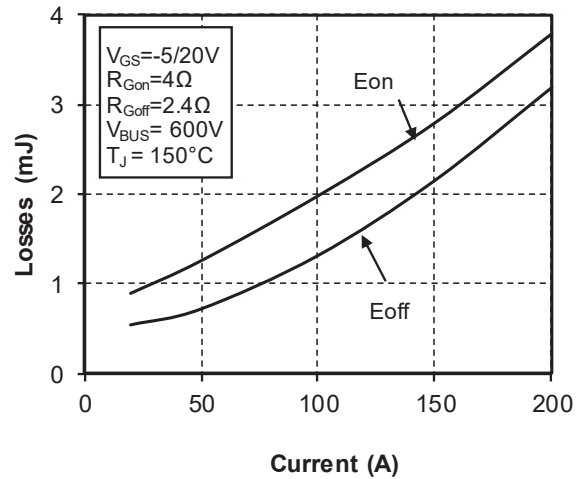


Figure 1-8. Capacitance vs. Drain Source Voltage

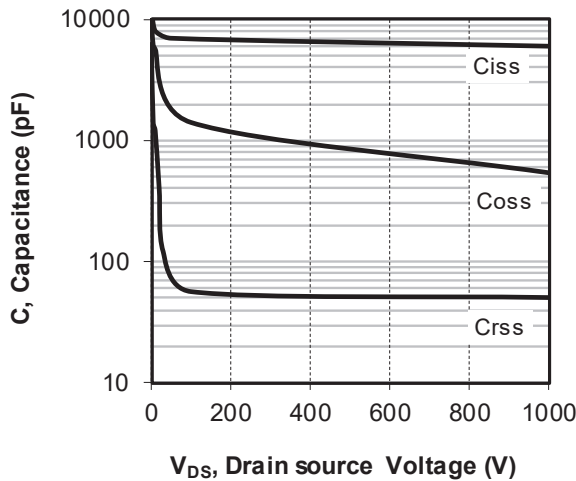


Figure 1-9. Gate Charge vs. Gate Source Voltage

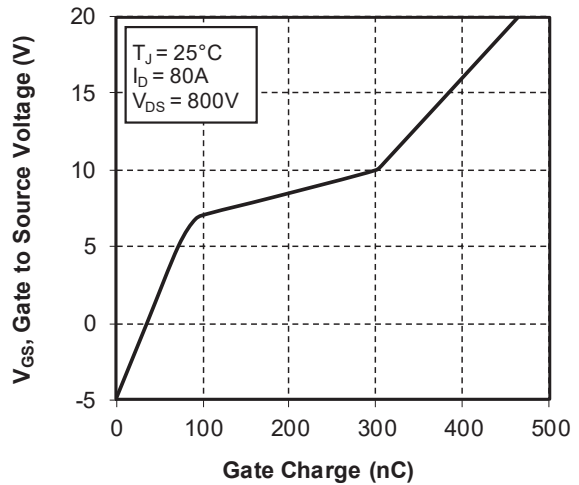


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

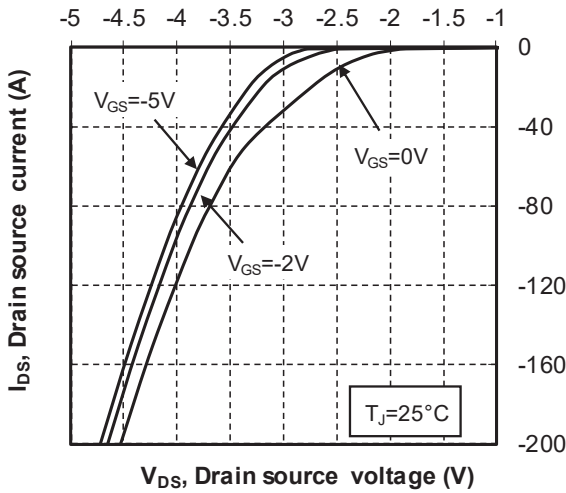


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

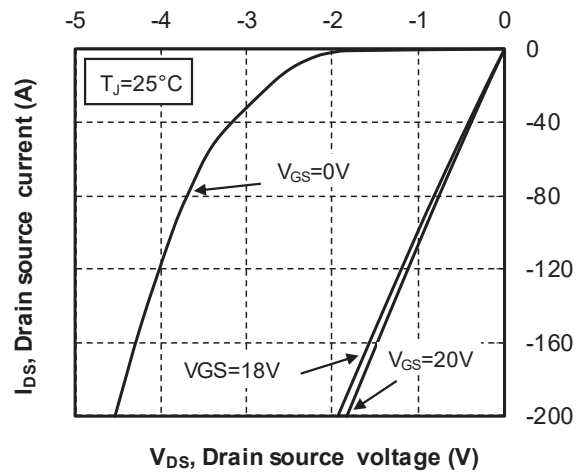


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

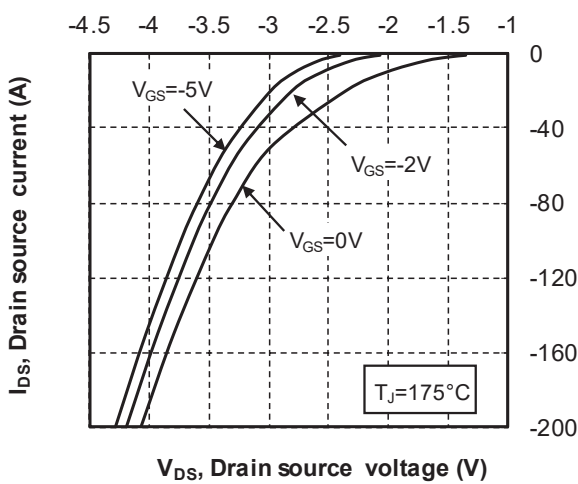


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

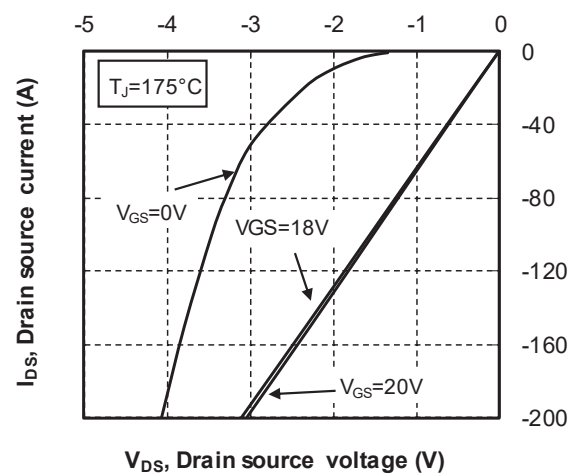
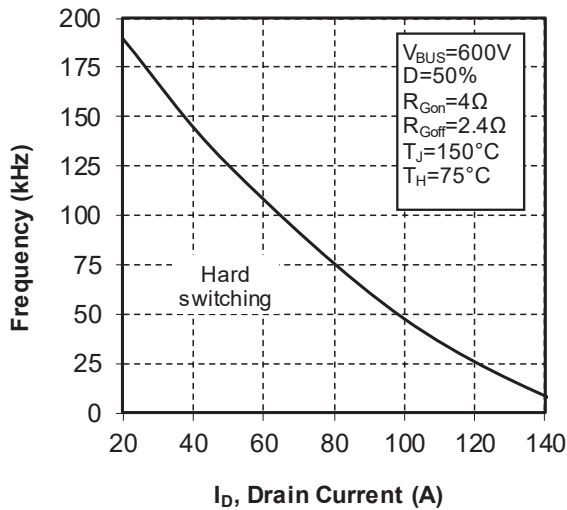


Figure 1-14. Operating Frequency vs. Drain Current

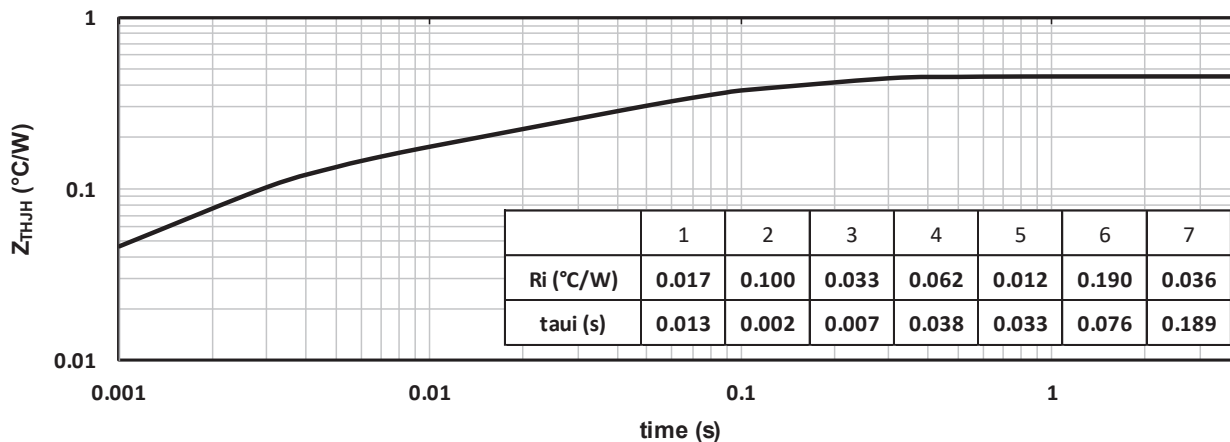




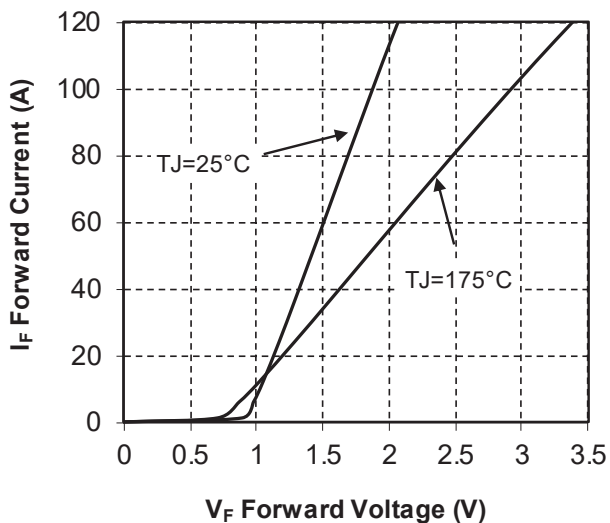
### 1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of MSCSM120DDUM16CTBL3NG device.

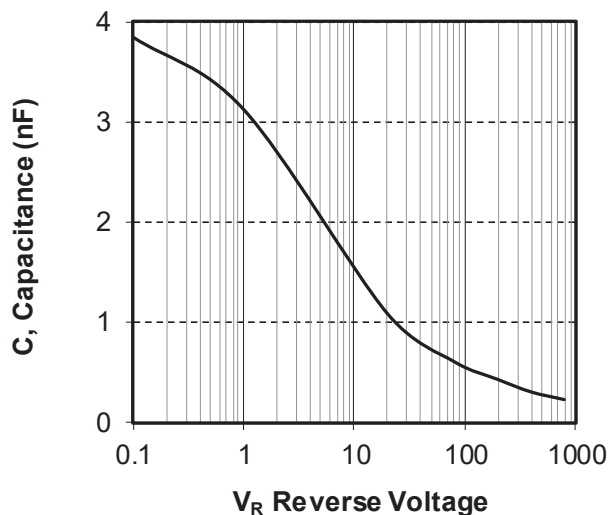
**Figure 1-15. Junction-to-Heatsink Thermal Impedance**



**Figure 1-16. Forward Characteristics**



**Figure 1-17. Capacitance vs. Reverse Voltage**



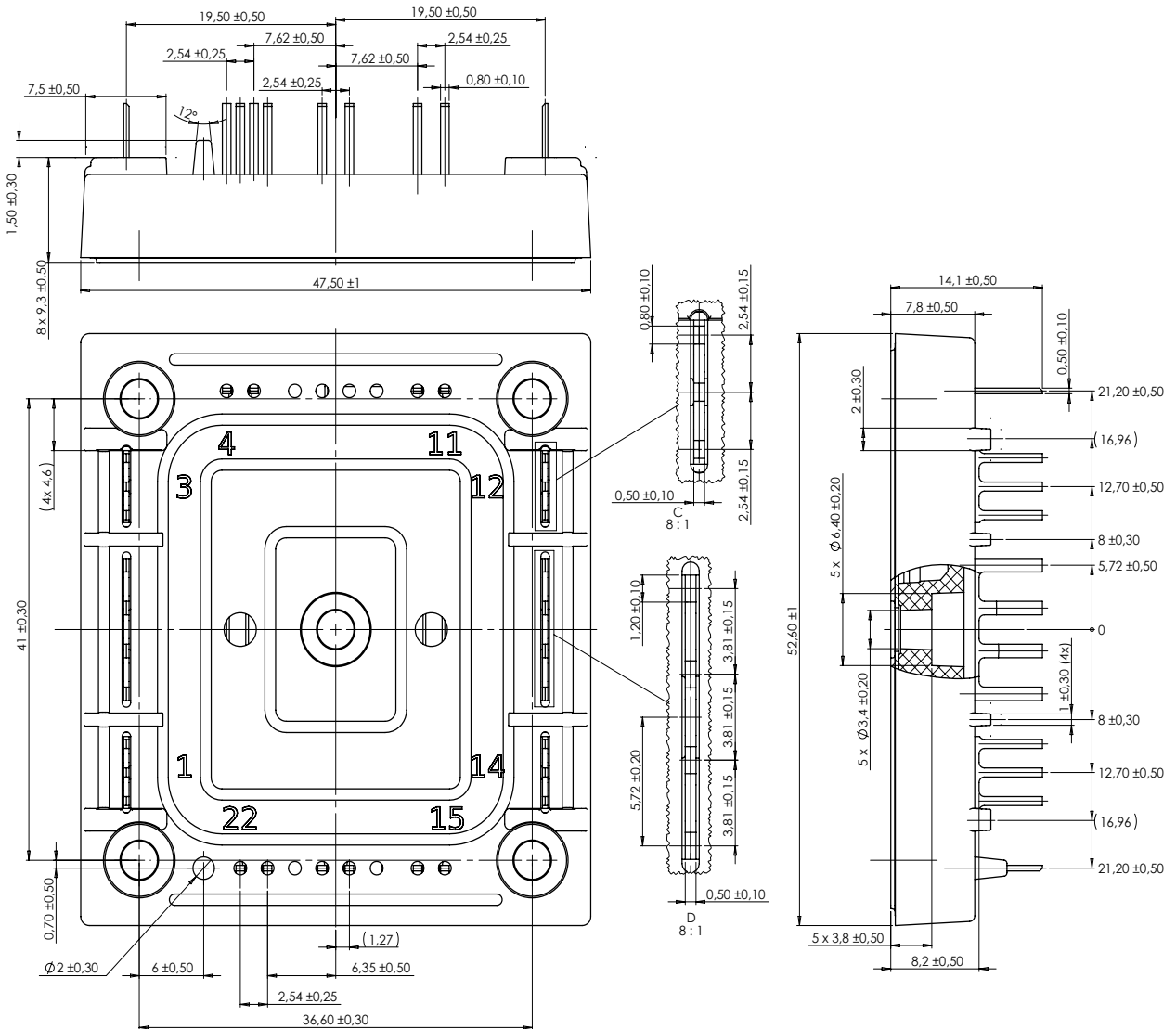
## 2. Package Specifications

The following section shows the package specification of MSCSM120DDUM16CTBL3NG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of MSCSM120DDUM16CTBL3NG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



### 3. Revision History

| Revision | Date    | Description      |
|----------|---------|------------------|
| A        | 07/2021 | Initial revision |

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