Three-Phase Bridge SiC MOSFET Power Module

MSCSM120XM31RTBL3NG

Product Overview

The MSCSM120XM31RTBL3NG device is a three-phase bridge 1200V, 79A Silicon Carbide (SiC) power module.

The following figures show the electrical diagram and pinout location of the device.

Figure 1. Electrical Diagram

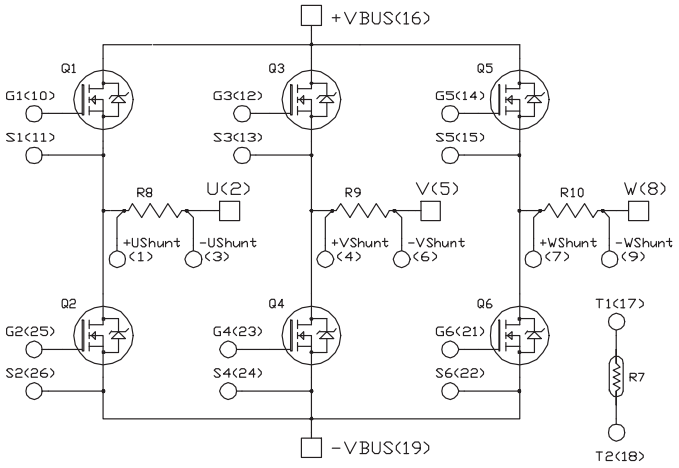
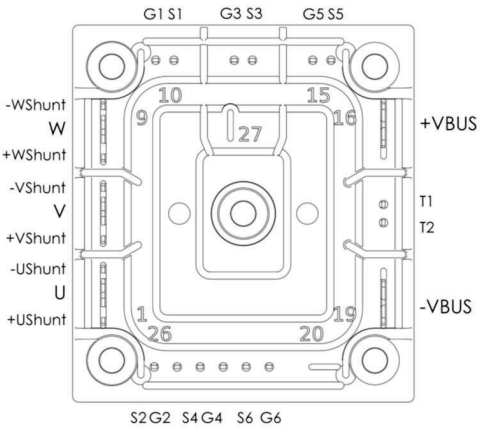
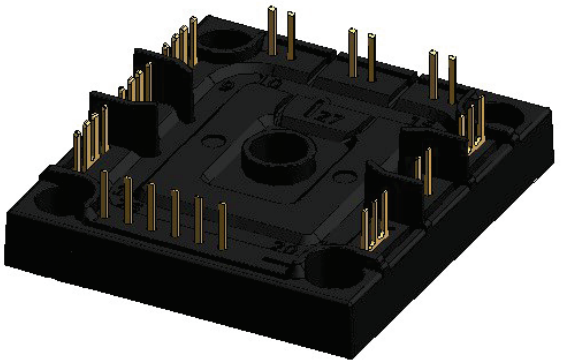


Figure 2. Pinout Location





Note: All ratings are at T_J = 25 °C, unless otherwise specified.

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

Features

The MSCSM120XM31RTBL3NG device has the following key features:

- SiC Power MOSFET
  - High speed switching
  - Low $R_{DS(on)}$
- Very low stray inductance
- 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

The MSCSM120XM31RTBL3NG device has the following benefits:

- 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
- Very integrated power conversion system
- Low profile
- RoHS Compliant

Application

The MSCSM120XM31RTBL3NG device has the following applications:

- High reliability drive
- Medium and heavy drones
- Aircraft actuation systems

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM120XM31RTBL3NG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM120XM31RTBL3NG 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 °C	79	A
		T_H = 80 °C	63	
I_{DM}	Pulsed drain current		160	
V_{GS}	Gate-source voltage		–10/23	V
$R_{DS(on)}$	Drain-source ON resistance		31	mΩ
P_D	Power dissipation	T_H = 25 °C	310	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM120XM31RTBL3NG 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} = 1200V		—	10	100	µA
$R_{DS(on)}$	Drain-source ON resistance	V_{GS} = 20V	T_J = 25 °C	—	25	31	mΩ
		I_D = 40A	T_J = 175 °C	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 3 mA		1.8	2.8	—	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	150	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM120XM31RTBL3NG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	3020	—	pF
C_{oss}	Output capacitance	V_{DS} = 1000V		—	270	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	25	—	
Q_g	Total gate charge	V_{GS} = –5V/20V		—	232	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 800V		—	41	—	
Q_{gd}	Gate-drain charge	I_D = 40A		—	50	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V	T_J = 150 °C	—	30	—	ns
T_r	Rise time	V_{Bus} = 600V		—	30	—	
$T_{d(off)}$	Turn-off delay time	I_D = 50A		—	50	—	
T_f	Fall time	R_{Gon} = 8Ω R_{Goff} = 4.7Ω		—	25	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V	T_J = 150 °C	—	1.2	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 600V I_D = 50A R_{Gon} = 8Ω R_{Goff} = 4.7Ω		—	0.66	—	
R_{Gint}	Internal gate resistance			—	0.88	—	Ω
R_{thJH}	Junction-to-heatsink thermal resistance		λ = 3.4 W/mK	—	0.483	—	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM120XM31RTBL3NG 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} = 40A	—	4	—	V
		V_{GS} = –5V; I_{SD} = 40A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 40A	—	90	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5V	—	550	—	nC
I_{rr}	Reverse recovery current	V_R = 800V di_F/dt = 1000 A/µs	—	13.5	—	A

1.2 Electrical Shunt Characteristics

The following tables list the electrical shunt characteristics of the MSCSM120XM31RTBL3NG device.

Table 1-5. Shunt (R8 to R10)

Symbol	Characteristic		Min.	Typ.	Max.	Unit
R_i	Resistance value	i = 8, 9, and 10	—	2	—	mΩ
T_{Ri}	Tolerance	TCE = 50 ppm	—	1	1.5	%
P_{Ri}	Load capacity		—	—	3	W
I_{Ri}	Current capacity		—	—	38	A

1.3 Temperature Sensor NTC

The following table lists the temperature sensor NTC of the MSCSM120XM31RTBL3NG device.

Table 1-6. Temperature Sensor NTC

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} = 298.15K		—	3952	—	K
ΔB/B	—	T_H = 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: For more information, see APT0406—Using NTC Temperature Sensor Integrated into Power Module.

1.4 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120XM31RTBL3NG device.

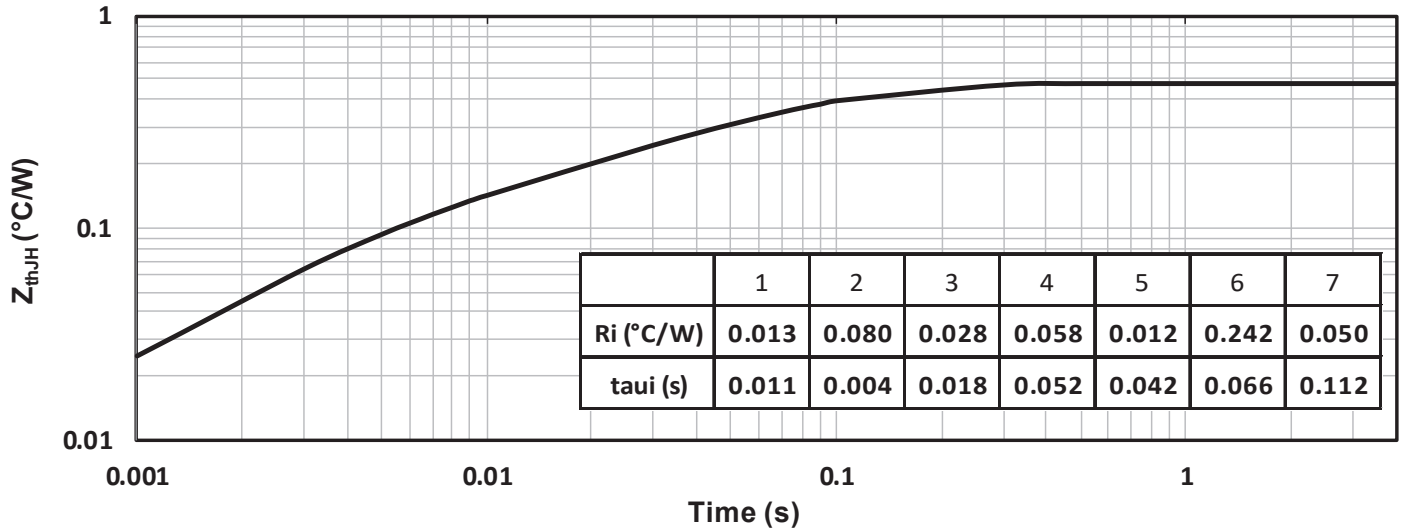
Table 1-7. Thermal and Package Characteristics

Symbol	Characteristic			Min.	Typ.	Max.	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50/60 Hz			2500	—	—	V
CTI	Comparative tracking index			600	—	—	—
T_J	Operating junction temperature range			–55	—	175	°C
T_{JOP}	Recommended junction temperature under switching conditions			–55	—	T_{Jmax}–25	
T_{STG}	Storage temperature range			–55	—	125	
T_C	Operating case temperature			–55	—	125	
Torque	Mounting torque	To heatsink	M3	0.7	—	0.9	N.m
Wt	Package weight			—	32.5	—	g

1.5 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM120XM31RTBL3NG device.

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



	1	2	3	4	5	6	7
Ri (°C/W)	0.013	0.080	0.028	0.058	0.012	0.242	0.050
taui (s)	0.011	0.004	0.018	0.052	0.042	0.066	0.112

Figure 1-2. Output Characteristics, T_J = 25 °C

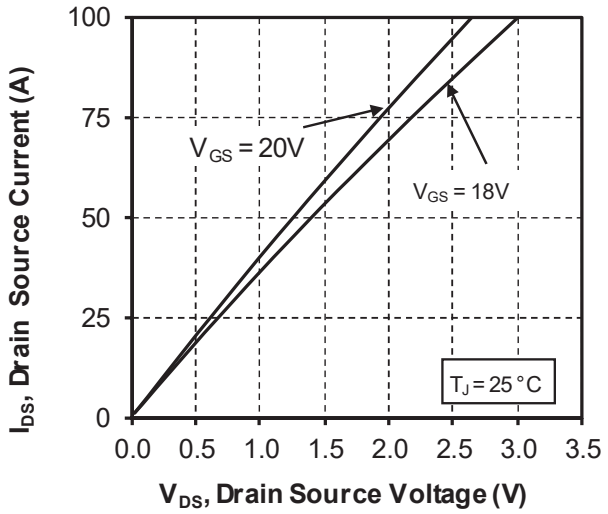


Figure 1-3. Output Characteristics, T_J = 175 °C

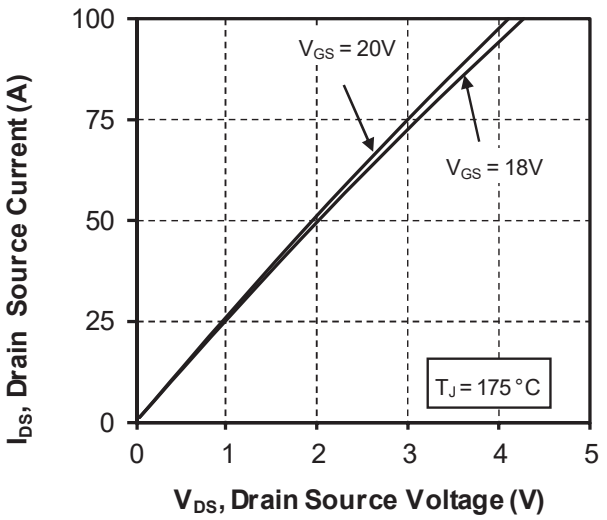


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

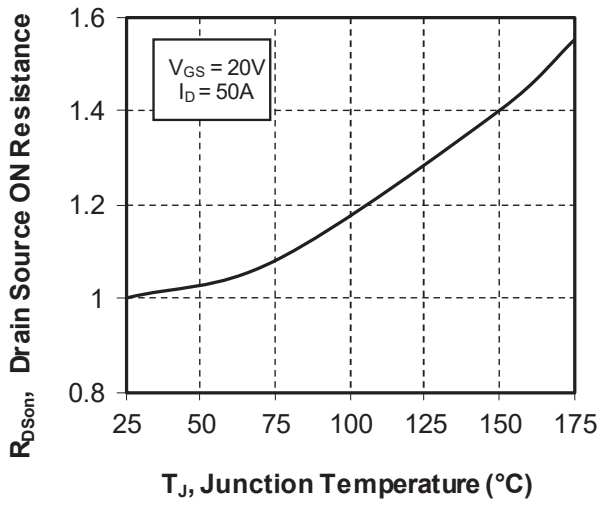


Figure 1-5. Transfer Characteristics

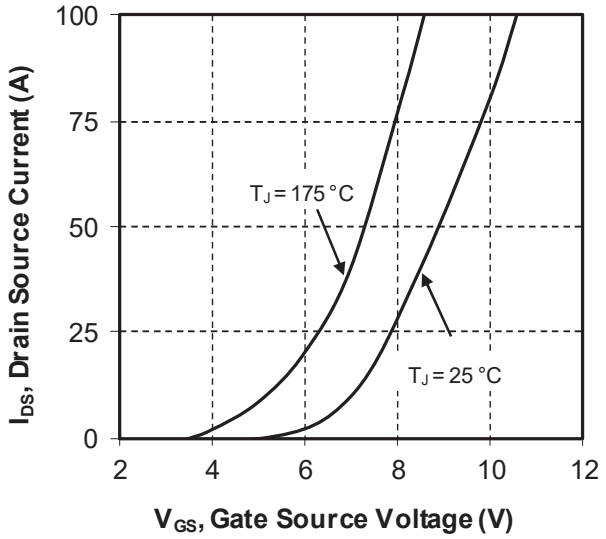


Figure 1-6. Switching Energy vs. Rg

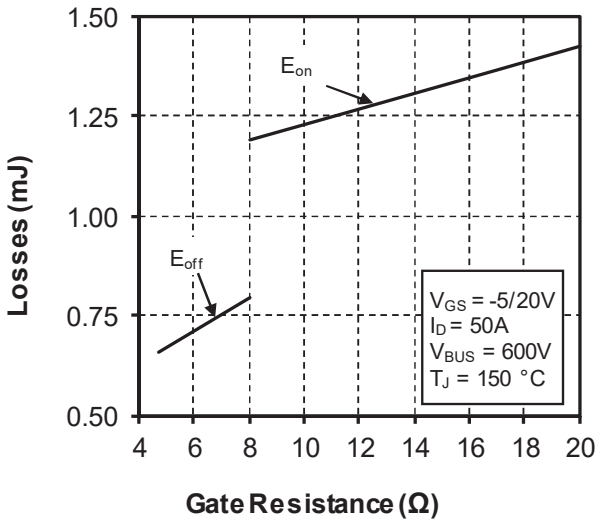


Figure 1-7. Switching Energy vs. Current

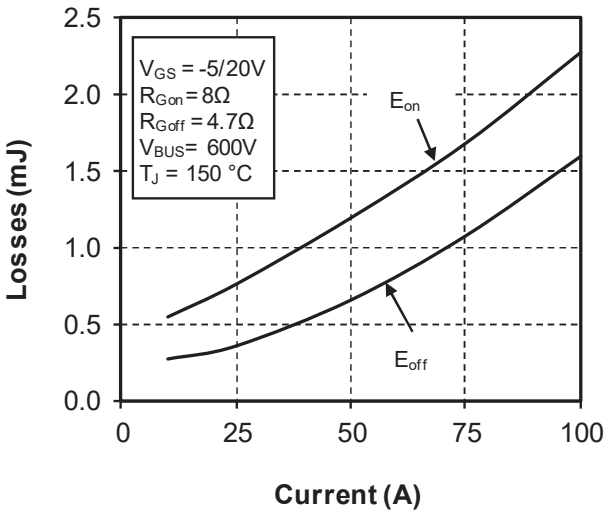


Figure 1-8. Capacitance vs. Drain Source Voltage

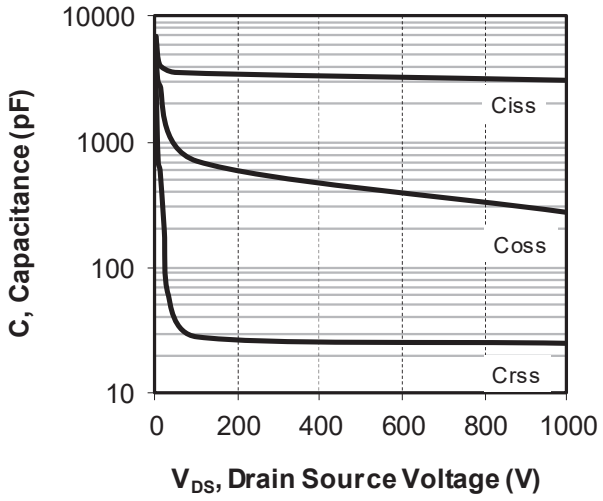


Figure 1-9. Gate Charge vs. Gate Source Voltage

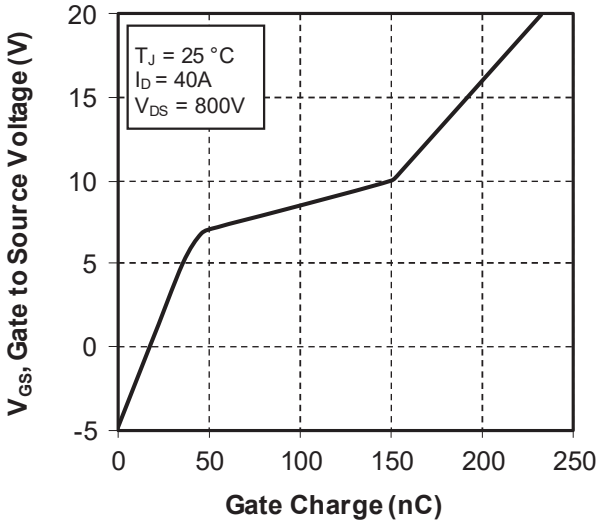


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

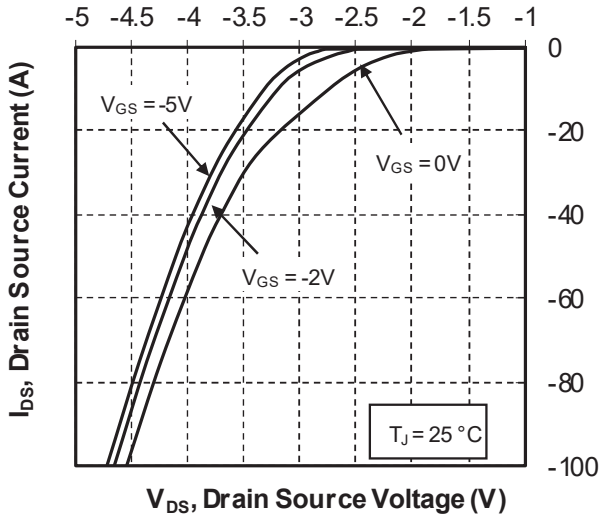


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

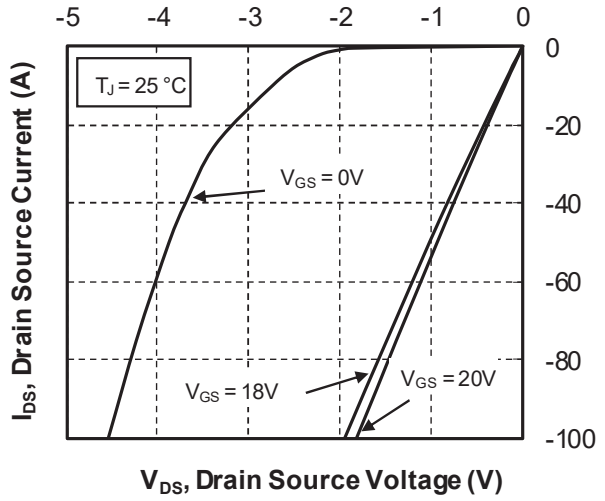


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

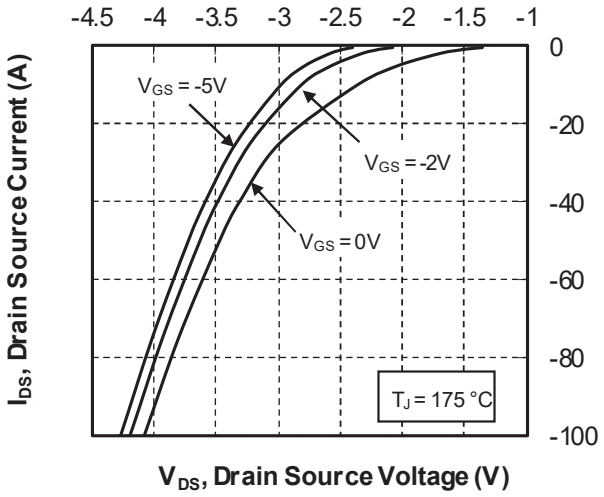


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

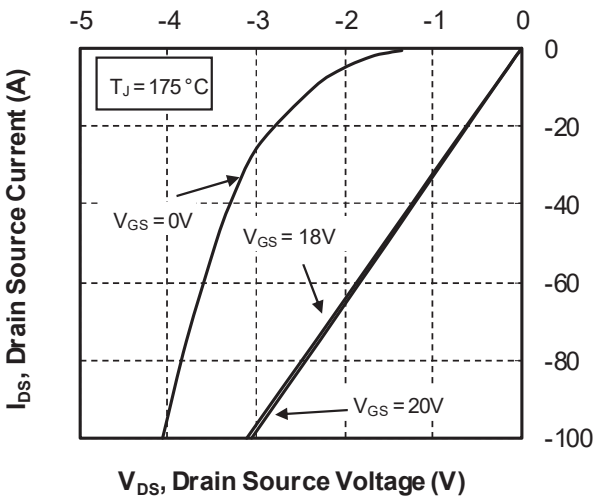
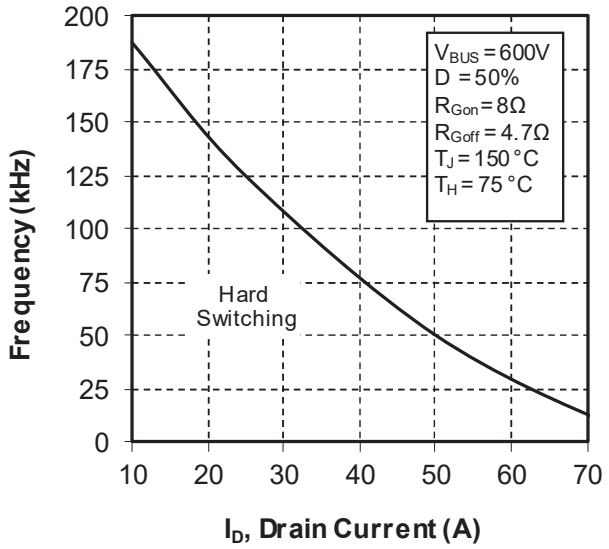


Figure 1-14. Operating Frequency vs. Drain Current



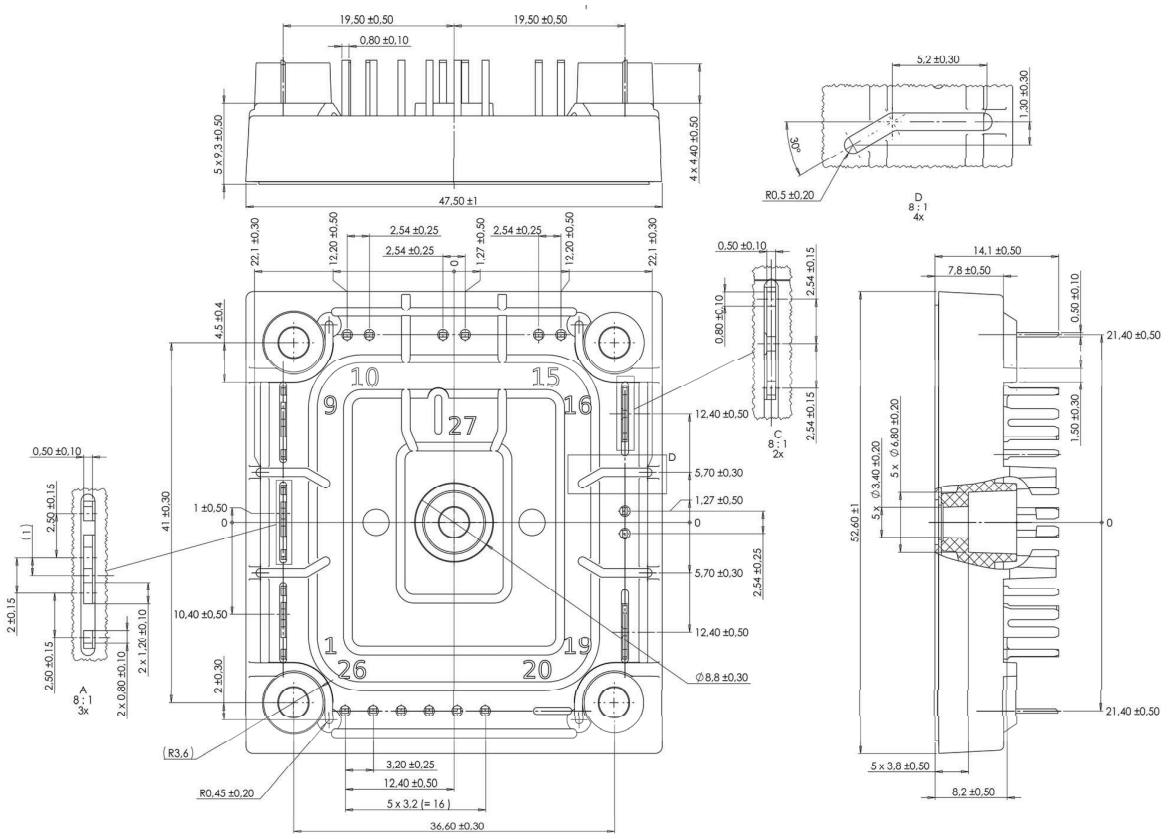
2. Package Specifications

The following section shows the package specification of the MSCSM120XM31RTBL3NG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120XM31RTBL3NG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: For more information, see application note AN4306-Mounting Instruction for Baseless Power Module.

3. 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.

Revision	Date	Description
A	09/2023	Initial revision

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