Phase Leg SiC MOSFET Power Module

MSCSMC120AM04TBZ2EG

Product Overview

The MSCSMC120AM04TBZ2EG device is a phase leg 1200V, 236A Silicon Carbide (SiC) power module.

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

Figure 1. Electrical Diagram

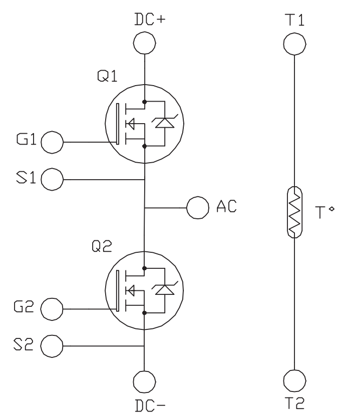
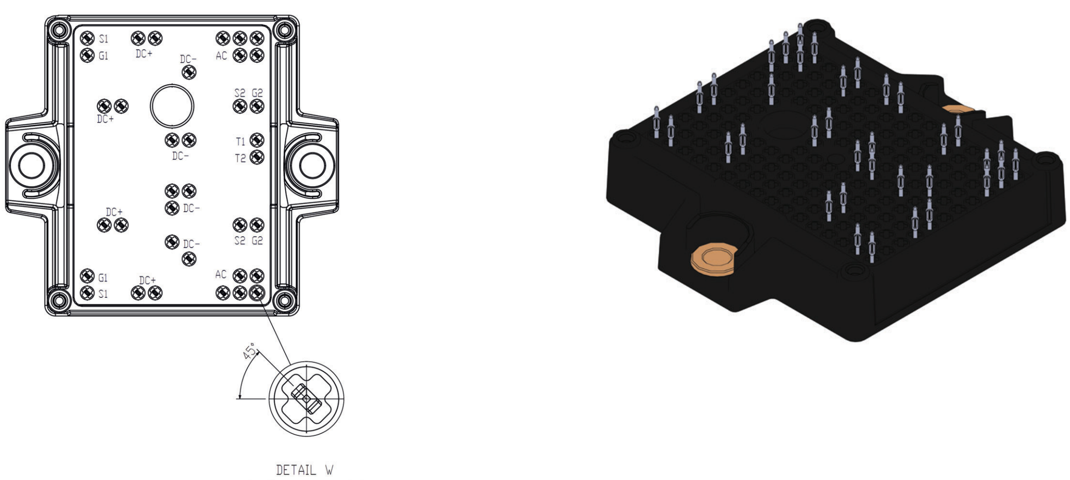


Figure 2. Pinout Location



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 MSCSMC120AM04TBZ2EG device has the following key features:

- SiC Power MOSFET
  - Low switching and conduction losses
  - Low $R_{DS(on)}$ over temperature drift
- Ultra low weight and profile
- Internal thermistor for temperature monitoring
- Al_2O_3 substrate

Benefits

The MSCSMC120AM04TBZ2EG device has the following benefits:

- Superior efficiency performance
- Superior performance over temperature due to low $R_{DS(on)}$ increase at elevated temperatures
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-heatsink thermal resistance
- Press-fit terminals for easy assembly
- Low profile
- RoHS Compliant

Application

The MSCSMC120AM04TBZ2EG device has the following applications:

- Motor Drives
- General Purpose Inverters
- DC/DC converters
- EV chargers
- Renewable energy

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSMC120AM04TBZ2EG device.

1.1. SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSMC120AM04TBZ2EG 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	236	A
		T_H = 50 °C	215	
I_{DM}	Pulsed drain current, t_p limited by T_{Jmax}		450	
V_{GS}	Gate-source voltage		–10/21	V
	Transient Gate - Source Voltage		–12/23	
$R_{DS(on)}$	Drain-source ON resistance		6	mΩ
P_D	Power dissipation	T_H = 25 °C	604	W

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSMC120AM04TBZ2EG 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		—	—	90	µA
$R_{DS(on)}$	Drain–source ON resistance	V_{GS} = 18V I_D = 225A	T_J = 25 °C	—	4.7	6	mΩ
			T_J = 150 °C	—	7.5	—	
			T_J = 175 °C	—	8.5	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 13.5 mA		1.9	3	5	V
I_{GSS}	Gate–source leakage current	V_{GS} = 18V; V_{DS} = 0V		—	—	300	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSMC120AM04TBZ2EG 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 = 100 kHz		—	17.8	—	nF
C_{oss}	Output capacitance			—	0.8	—	
C_{rss}	Reverse transfer capacitance			—	0.06	—	
Q_g	Total gate charge	V_{GS} = –5/18V V_{Bus} = 800V I_D = 120A		—	726	—	nC
Q_{gs}	Gate-source charge			—	210	—	
Q_{gd}	Gate-drain charge			—	120	—	
$t_{d(on)}$	Turn-on delay time	V_{GS} = –5/18V V_{Bus} = 600V I_D = 225A R_{Gon} = 2.7Ω R_{Goff} = 0.5Ω	T_J = 25 °C	—	61	—	ns
			T_J = 150 °C	—	56	—	
t_r	Rise time		T_J = 25 °C	—	31	—	
			T_J = 150 °C	—	27	—	
$t_{d(off)}$	Turn-off delay time		T_J = 25 °C	—	98	—	
			T_J = 150 °C	—	115	—	
t_f	Fall time		T_J = 25 °C	—	29	—	
			T_J = 150 °C	—	31	—	
E_{on}	Turn-on energy	V_{GS} = –5/18V V_{Bus} = 600V I_D = 225A R_{Gon} = 2.7Ω R_{Goff} = 0.5Ω di/dt = 5.8 kA/μs dv/dt = 24 kV/μs	T_J = 25 °C	—	4.6	—	mJ
			T_J = 150 °C	—	4.8	—	
E_{off}	Turn-off energy		T_J = 25 °C	—	2	—	
			T_J = 150 °C	—	2.3	—	
R_{Gint}	Internal gate resistance			—	3.2	—	Ω
R_{thJH}	Junction-to-heatsink thermal resistance	λ= 3.4 W/mK		—	0.248	—	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSMC120AM04TBZ2EG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	V_{GS} = –5V I_{SD} = 225A	T_J = 25 °C	—	4.7	—	V
			T_J = 150 °C	—	4.3	—	
t_{rr}	Reverse recovery time	V_R = 600V I_{SD} = 225A V_{GS} = –5V di_F/dt = 5.8 kA/μs	T_J = 25 °C	—	26	—	ns
			T_J = 150 °C	—	35	—	
Q_{rr}	Reverse recovery charge		T_J = 25 °C	—	1.3	—	μC
			T_J = 150 °C	—	2.9	—	
I_{rr}	Reverse recovery current		T_J = 25 °C	—	99	—	A
			T_J = 150 °C	—	165	—	
E_{rr}	Reverse recovery energy		T_J = 25 °C	—	0.24	—	mJ
			T_J = 150 °C	—	0.84	—	

1.2. Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSMC120AM04TBZ2EG device.

Table 1-5. Thermal and Package Characteristics

<table>
<tr><th>Symbol</th><th colspan="3">Characteristic</th><th>Min.</th><th>Typ.</th><th>Max.</th><th>Unit</th></tr>
<tr><td>V_{ISOL}</td><td colspan="3">RMS isolation voltage, any terminal-to-case t = 1 min, 50/60 Hz</td><td>3000</td><td>—</td><td>—</td><td>V</td></tr>
<tr><td>T_J</td><td colspan="3">Operating junction temperature range</td><td>–40</td><td>—</td><td>175</td><td rowspan="4">°C</td></tr>
<tr><td>T_{JOP}</td><td colspan="3">Recommended junction temperature under switching conditions</td><td>–40</td><td>—</td><td>T_{Jmax}–25</td></tr>
<tr><td>T_{STG}</td><td colspan="3">Storage temperature range</td><td>–40</td><td>—</td><td>125</td></tr>
<tr><td>T_C</td><td colspan="3">Operating case temperature</td><td>–40</td><td>—</td><td>125</td></tr>
<tr><td>τM</td><td>Mounting torque</td><td>To heatsink</td><td>M4</td><td>1.5</td><td>—</td><td>2</td><td>N.m</td></tr>
<tr><td>R</td><td>Module lead resistance terminal-to-chip</td><td colspan="2">Per switch</td><td>—</td><td>1.4</td><td>—</td><td>mΩ</td></tr>
<tr><td>L_{stray}</td><td colspan="3">Module stray inductance between DC+ and DC−</td><td>—</td><td>7</td><td>—</td><td>nH</td></tr>
<tr><td>Wt</td><td colspan="3">Package weight</td><td>—</td><td>40</td><td>—</td><td>g</td></tr>
</table>

Note: T_J > 150°C is only allowed for operation at overload conditions

The following table lists the temperature sensor characteristics of the MSCSMC120AM04TBZ2EG device.

Table 1-6. Temperature Sensor Characteristics

Symbol	Characteristic	Min.	Typ.	Max.	Unit
R_{25}	Resistance @ 25°C	—	5	—	kΩ
$\Delta R_{25}/R_{25}$		—	5	—	%
$B_{25/50}$	T_{25} = 298.15 K	—	3380	—	K
ΔB/B		—	2	—	%

Note:

$$R_T = \frac{R_{25}}{\exp\left[B_{25/50}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

Where

- T: Thermistor temperature
- R_T: Thermistor value at T

Note: For more information, see the latest application note on NTC temperature sensor, available on the Microchip website.

1.3. Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSMC120AM04TBZ2EG device.

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

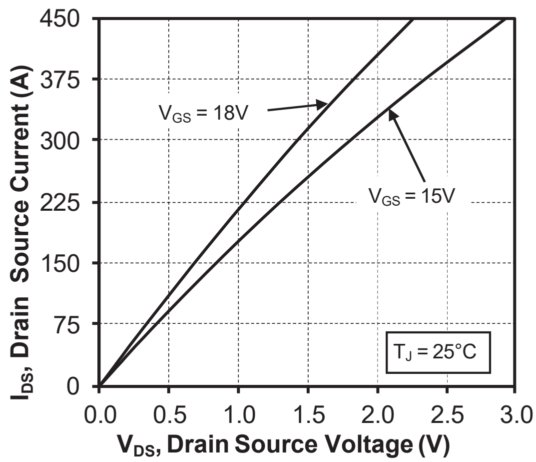


Figure 1-2. Output Characteristics, T_J = 150 °C

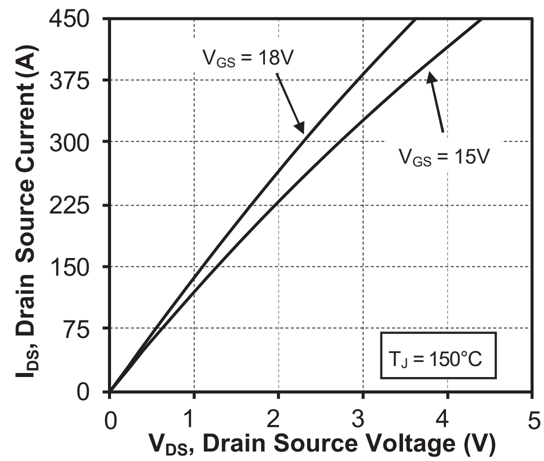


Figure 1-3. Output Characteristics, T_J = 175 °C

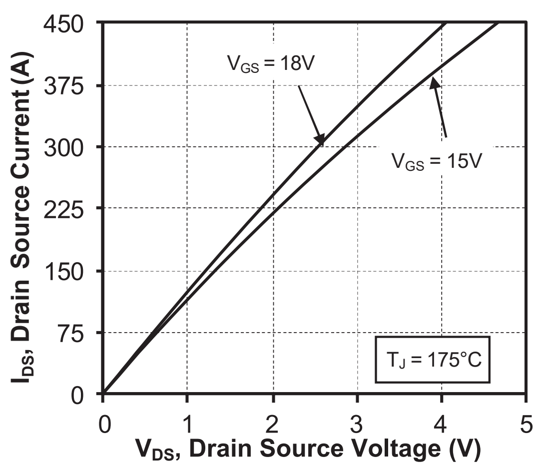


Figure 1-4. Switching Energy vs. Current

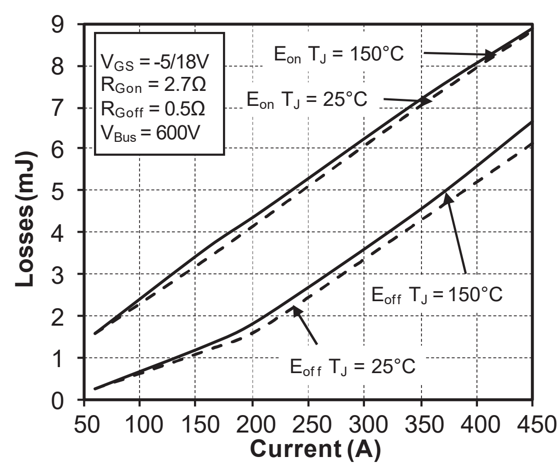


Figure 1-5. Switching Energy vs. R_G

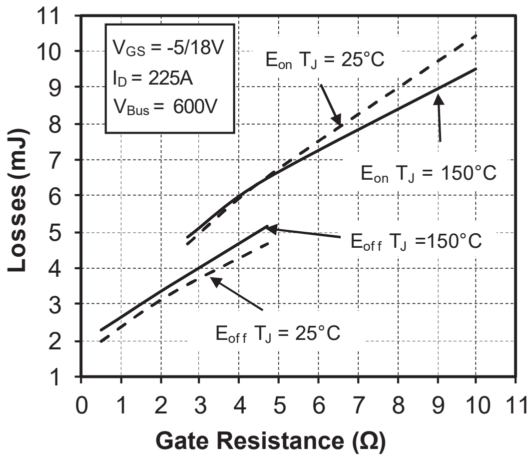
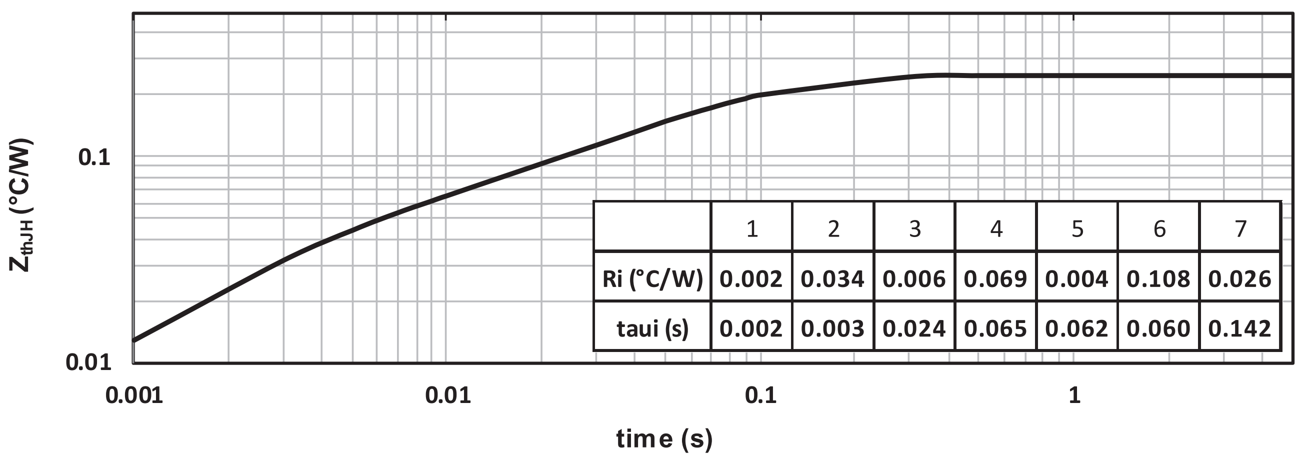


Figure 1-6. Junction-to-Heatsink Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.034	0.006	0.069	0.004	0.108	0.026
taui (s)	0.002	0.003	0.024	0.065	0.062	0.060	0.142

Figure 1-7. Capacitance vs. Drain Source Voltage

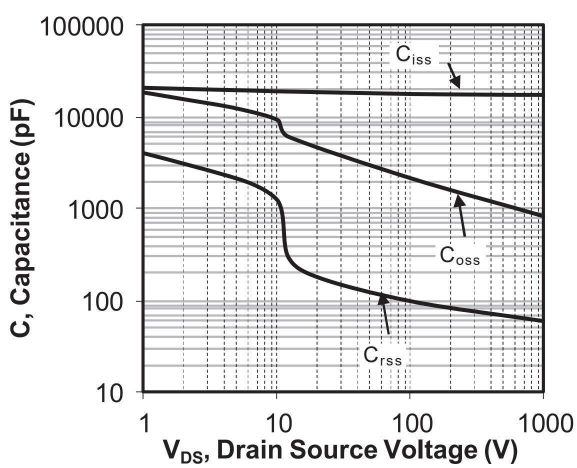


Figure 1-8. Gate Charge vs. Gate Source Voltage

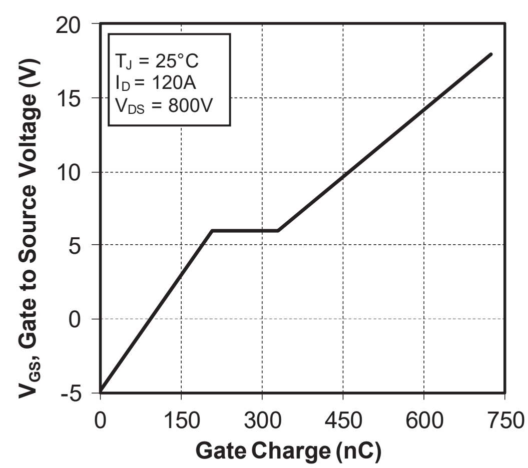


Figure 1-9. Body Diode Characteristics, T_J = 25 °C

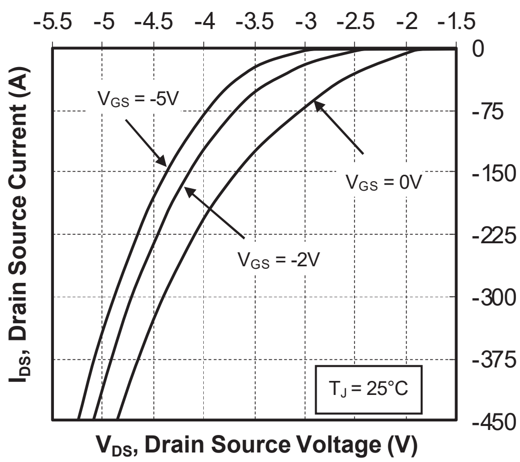


Figure 1-10. 3rd Quadrant Characteristics, T_J = 25 °C

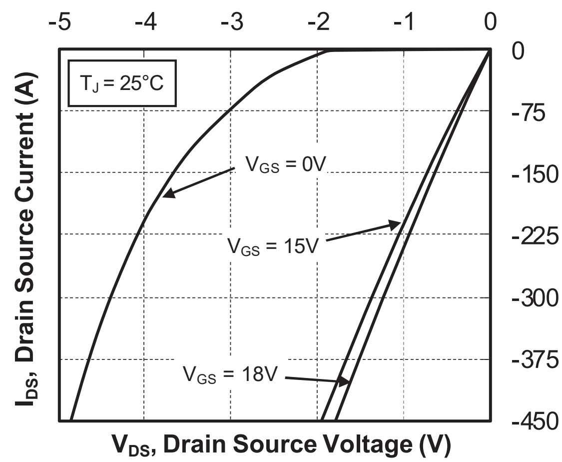


Figure 1-11. Body Diode Characteristics, T_J = 150 °C

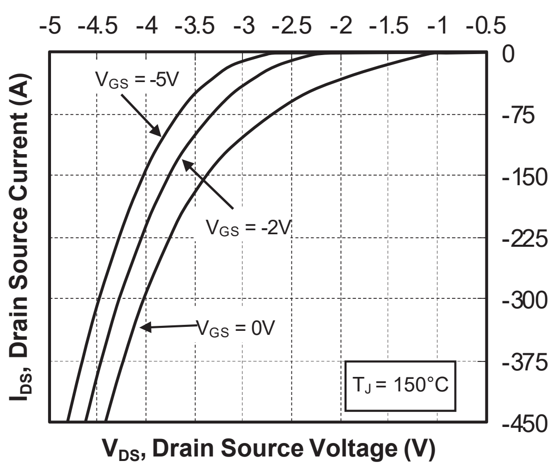


Figure 1-12. 3rd Quadrant Characteristics, T_J = 150 °C

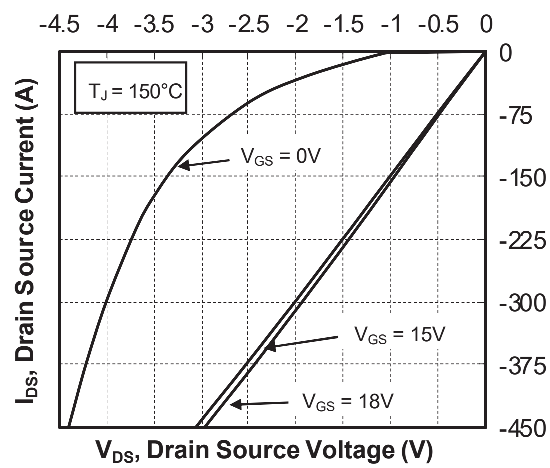


Figure 1-13. Body Diode Characteristics, T_J = 175 °C

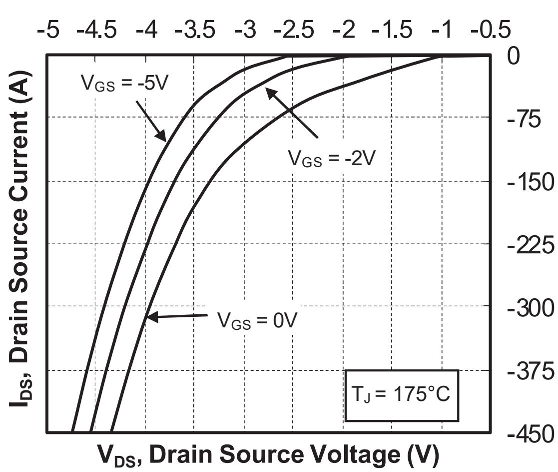


Figure 1-14. 3rd Quadrant Characteristics, T_J = 175 °C

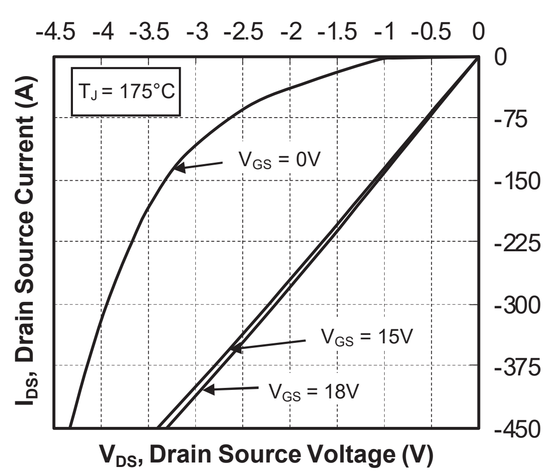


Figure 1-15. Switching Times vs. Drain Current

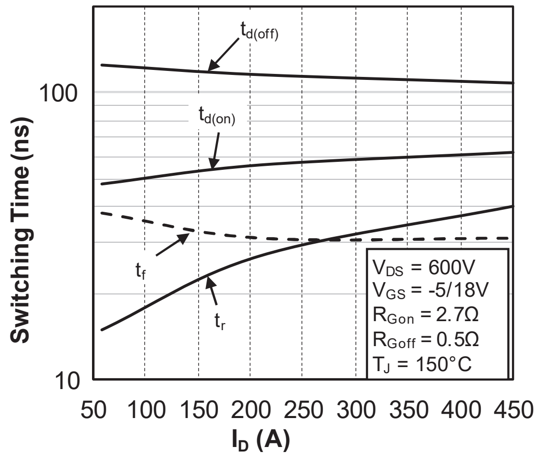


Figure 1-16. Switching Times vs. Gate Resistance

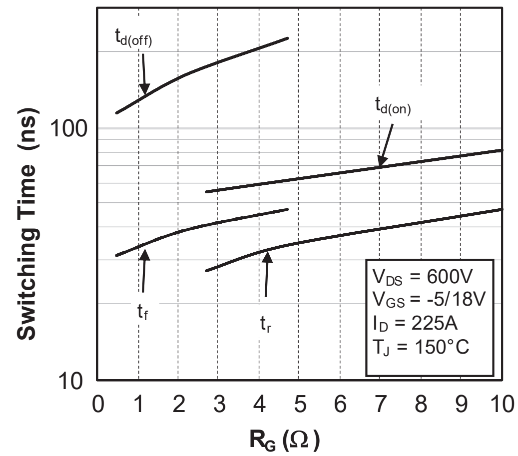


Figure 1-17. E_{rr} vs. Current

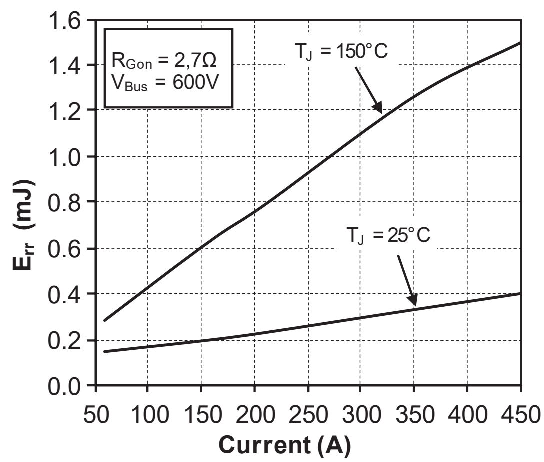


Figure 1-18. E_{rr} vs. Gate Resistance

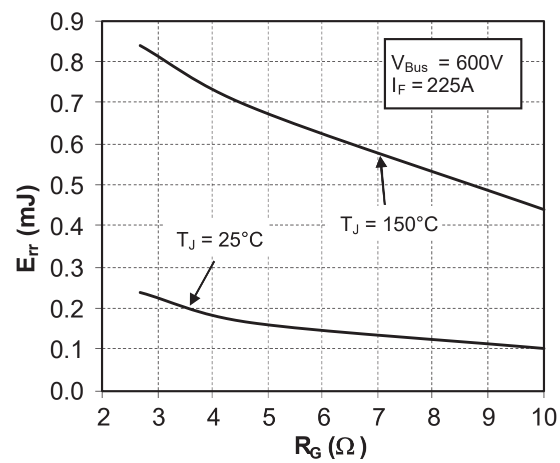


Figure 1-19. Operating Frequency vs. Drain Current

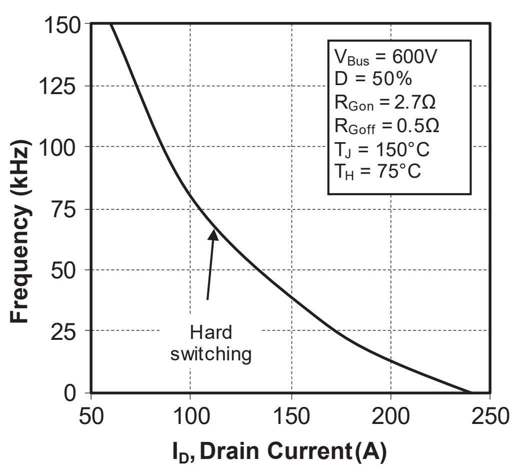
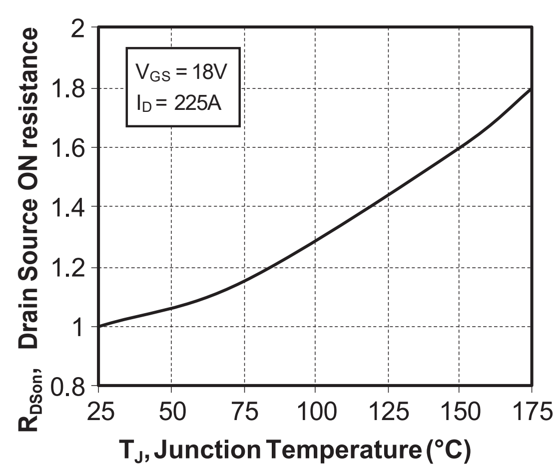


Figure 1-20. Normalized $R_{DS(on)}$ vs. Temperature



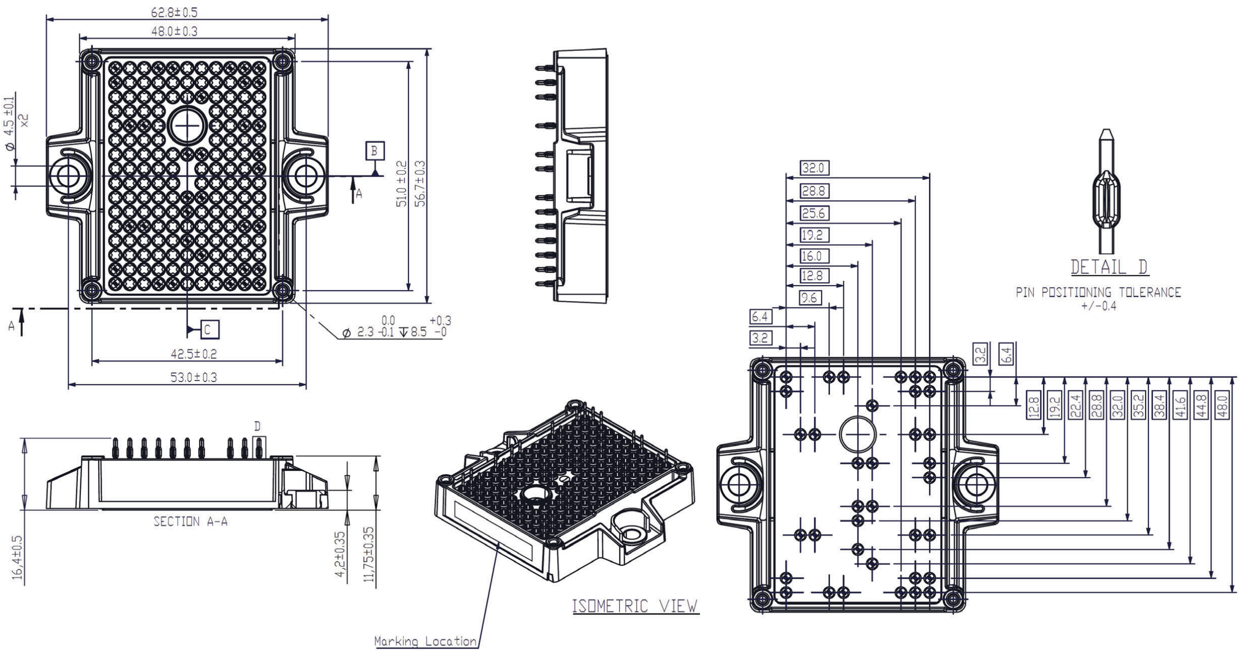
2. Package Specifications

The following section shows the package specification of the MSCSMC120AM04TBZ2EG device.

2.1. Package Outline

The following figure shows the package outline drawing of the MSCSMC120AM04TBZ2EG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: PCB diameters of drill ⌀ 1.15 mm and copper thickness in hole 25-50µm.

Note: For more information, see the latest application note on mounting instruction for BZ pressfit power modules, available on the Microchip website.

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	03/2026	Initial Revision

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