ANPC Power Module

MSCSMG120ANPCM11TPAG

Product Overview

The MSCSMG120ANPCM11TPAG device is an ANPC 1200V, Silicon Carbide (SiC) power module.

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

Figure 1. Electrical Diagram

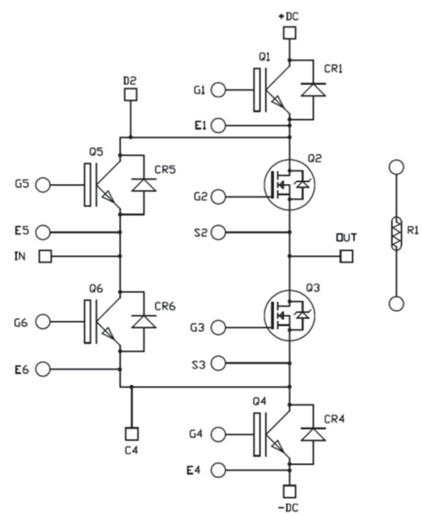
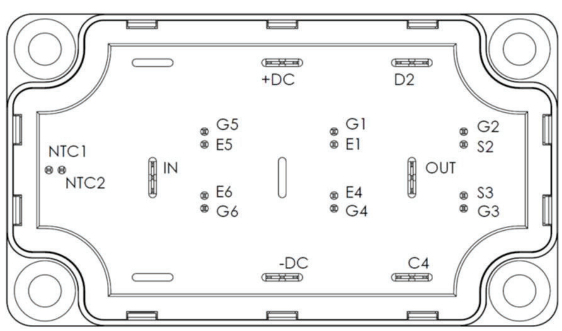


Figure 2. Pinout Location



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.

© 2025 Microchip Technology Inc. and its subsidiaries

Features

The MSCSMG120ANPCM11TPAG device has the following key features:

- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- IGBT7
  - Low voltage drop
  - Low leakage current
- Low stray inductance
- Internal thermistor for temperature monitoring
- AlN substrate for improved thermal performance
- Copper baseplate

Benefits

The MSCSMG120ANPCM11TPAG device has the following benefits:

- High power and efficiency converters and inverters
- Direct mounting to heat sink (isolated package)
- Low junction to case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS Compliant

Application

The MSCSMG120ANPCM11TPAG device has the following applications:

- AC/DC converter (ANPC hybrid configuration)

© 2025 Microchip Technology Inc. and its subsidiaries

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSMG120ANPCM11TPAG device.

1.1. SiC MOSFET Characteristics (per SiC MOSFET)

The following table lists the absolute maximum ratings of the MSCSMG120ANPCM11TPAG 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_C = 25 °C	251	A
		T_C = 80 °C	200	
I_{DM}	Pulsed drain current		500	
V_{GS}	Gate-source voltage		–10/23	V
$R_{DS(on)}$	Drain-source ON resistance		10.4	mΩ
P_D	Power dissipation	T_C = 25 °C	1042	W

The following table lists the electrical characteristics of the MSCSMG120ANPCM11TPAG 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		—	30	300	µA
$R_{DS(on)}$	Drain–source ON resistance	V_{GS} = 20V I_D = 120A	T_J = 25°C	—	8.4	10.4	mΩ
			T_J = 175°C	—	13.4	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 9 mA		1.8	2.8	—	V
I_{GSS}	Gate–source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	300	nA

The following table lists the dynamic characteristics of the MSCSMG120ANPCM11TPAG 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 = 1 MHz		—	9060	—	pF
C_{oss}	Output capacitance			—	810	—	
C_{rss}	Reverse transfer capacitance			—	75	—	
Q_g	Total gate charge	V_{GS} = –5/20V V_{Bus} = 800V I_D = 120A		—	696	—	nC
Q_{gs}	Gate-source charge			—	123	—	
Q_{gd}	Gate-drain charge			—	150	—	
$t_{d(on)}$	Turn-on delay time	V_{GS} = –5/20V V_{Bus} = 600V I_D = 150A R_{Gon} = 2.7Ω; R_{Goff} = 1.6Ω		—	30	—	ns
t_r	Rise time			—	30	—	
$t_{d(off)}$	Turn-off delay time			—	50	—	
t_f	Fall time			—	25	—	
E_{on}	Turn-on energy	V_{GS} = –5/+20V V_{Bus} = 600V I_D = 150A R_{Gon} = 2.7Ω R_{Goff} = 1.6Ω	T_J = 150°C	—	3.6	—	mJ
E_{off}	Turn-off energy		T_J = 150°C	—	2	—	
R_{Gint}	Internal gate resistance			—	2	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.144	°C/W

© 2025 Microchip Technology Inc. and its subsidiaries

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSMG120ANPCM11TPAG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Body diode forward voltage	V_{GS} = 0V; I_{SD} = 120A	—	4	—	V
		V_{GS} = −5V; I_{SD} = 120A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 120A; V_{GS} = –5V V_R = 800V; di_F/dt = 3000 A/µs	—	90	—	ns
Q_{rr}	Reverse recovery charge		—	1650	—	nC
I_{rr}	Reverse recovery current		—	40.5	—	A

1.2. IGBT7 and Si Diode Parameters (per IGBT and diode)

The following table lists the absolute maximum ratings of the MSCSMG120ANPCM11TPAG device.

Table 1-5. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{CES}	Collector-emitter voltage		1200	V
I_C	Continuous collector current	T_C = 25°C	260	A
		T_C = 115°C	150	
I_{CM}	Pulsed collector current, t_p limited by $T_J$max		300	
V_{GE}	Gate-emitter voltage		±20	V
	Transient gate-emitter voltage		±25	
P_D	Power dissipation	T_C = 25 °C	777	W

The following table lists the electrical characteristics of the MSCSMG120ANPCM11TPAG device.

Table 1-6. Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
I_{CES}	Zero gate voltage collector current	V_{GE} = 0V; V_{CE} = 1200V		—	—	12	µA
$V_{CE(sat)}$	Collector emitter saturation voltage	V_{GE} = 15V I_C = 150A	T_J = 25°C	—	1.55	1.8	V
			T_J = 125°C	—	1.7	—	
			T_J = 175°C	—	1.77	—	
$V_{GE(th)}$	Gate threshold voltage	V_{GE} = V_{CE}; I_C = 3.5 mA		5.15	5.8	6.45	V
I_{GES}	Gate–emitter leakage current	V_{GE} = 20V; V_{CE} = 0V		—	—	150	nA

© 2025 Microchip Technology Inc. and its subsidiaries

The following table lists the dynamic characteristics (per IGBT) of the MSCSMG120ANPCM11TPAG device.

Table 1-7. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{GE} = 0V V_{CE} = 25V f = 100 kHz		—	30	—	nF
C_{oes}	Output capacitance			—	0.38	—	
C_{res}	Reverse transfer capacitance			—	0.11	—	
Q_G	Gate charge	V_{GE} = ±15V; V_{CE} = 600V; I_C = 150A		—	2.5	—	μC
$t_{d(on)}$	Turn-on delay time	V_{GS} = ±15V V_{Bus} = 600V I_C = 150A R_G = 3.3Ω	T_J = 25°C	—	172	—	ns
			T_J = 125°C	—	183	—	
			T_J = 175°C	—	189	—	
t_r	Rise time		T_J = 25°C	—	72	—	
			T_J = 125°C	—	77	—	
			T_J = 175°C	—	80	—	
$t_{d(off)}$	Turn-off delay time		T_J = 25°C	—	331	—	
			T_J = 125°C	—	414	—	
			T_J = 175°C	—	433	—	
t_f	Fall time		T_J = 25°C	—	103	—	
			T_J = 125°C	—	198	—	
			T_J = 175°C	—	262	—	
E_{on}	Turn-on energy	V_{GE} = ±15V V_{Bus} = 600V I_C = 150A R_G = 3.3Ω di/dt = 1700 A/μs dv/dt = 3200 V/μs	T_J = 25°C	—	16.6	—	mJ
			T_J = 125°C	—	24.9	—	
			T_J = 175°C	—	29.6	—	
E_{off}	Turn-off energy		T_J = 25°C	—	10.4	—	
			T_J = 125°C	—	15.9	—	
			T_J = 175°C	—	19.9	—	
R_{Gint}	Internal gate resistance			—	1	—	Ω
I_{sc}	Short circuit data	V_{GE} ≤15V ; V_{Bus} = 800V ; t_p ≤ 8 μs ; T_J = 150°C		—	520	—	A
		V_{GE} ≤15V ; V_{Bus} = 800V ; t_p ≤ 7 μs ; T_J = 175°C		—	490	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.193	°C/W

© 2025 Microchip Technology Inc. and its subsidiaries

The following table lists the diode ratings and characteristics of the MSCSMG120ANPCM11TPAG device.

Table 1-8. Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	1200	V
I_{RM}	Reverse leakage current	V_R = 1200 V		—	—	8	µA
I_{FRM}	Repetitive forward current, t_p limited by $T_J$max			—	—	300	A
I^2t	I²t value	t_p = 10 ms V_R = 0V	T_J = 125°C	—	—	2700	A^2s
			T_J = 175°C	—	—	2250	
I_F	DC forward voltage	Tc = 90°C	T_J = 175 °C	—	150	—	A
V_F	Diode forward voltage	I_F = 150A V_{GE} = 0V	T_J = 25°C	—	1.75	2	V
			T_J = 125°C	—	1.6	—	
			T_J = 175°C	—	1.52	—	
I_{rrm}	Reverse recovery current	V_{GE} = −15 V I_F = 150A V_R = 600V di/dt = 1700 A/µs	T_J = 25°C	—	65	—	A
			T_J = 125°C	—	92	—	
			T_J = 175°C	—	107	—	
Q_{rr}	Reverse recovery charge		T_J = 25°C	—	10.3	—	µC
			T_J = 125°C	—	21.7	—	
			T_J = 175°C	—	28.6	—	
E_{rr}	Reverse recovery energy		T_J = 25°C	—	3.3	—	mJ
			T_J = 125°C	—	7.3	—	
			T_J = 175°C	—	9.9	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.318	°C/W

1.3. Package and Temperature Sensor Characteristics

The following table lists the thermal and package characteristics of the MSCSMG120ANPCM11TPAG device.

Table 1-9. Thermal and Package Characteristics

Symbol	Characteristic			Min.	Max.	Unit
V_{ISOL}	RMS isolation voltage, any terminal-to-case t = 1 min, 50/60 Hz			4000	—	V
T_J	Operating junction temperature range	SiC MOSFET		−40	175	°C
		IGBT & diode		−40	150	
T_{JOP}	Recommended junction temperature under switching conditions			−40	$T_J$max −25	
T_{STG}	Storage temperature range			−40	125	
T_C	Operating case temperature			−40	125	
τM	Mounting torque	To heat sink	M6	3	5	N.m
Wt	Package weight			—	250	g

The following table lists the temperature sensor characteristics of the MSCSMG120ANPCM11TPAG device.

Table 1-10. Temperature Sensor Characteristics

Symbol	Characteristic		Min.	Typ.	Max.	Unit
R_{25}	Resistance @ 25°C		—	50	—	kΩ
$\Delta R_{25}/R_{25}$			—	5	—	%
$B_{25/85}$	T_{25} = 298.15 K		—	3952	—	K
ΔB/B		T_C = 100°C	—	4	—	%

© 2025 Microchip Technology Inc. and its subsidiaries

Note:

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

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.

© 2025 Microchip Technology Inc. and its subsidiaries

1.4. Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSMG120ANPCM11TPAG device.

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

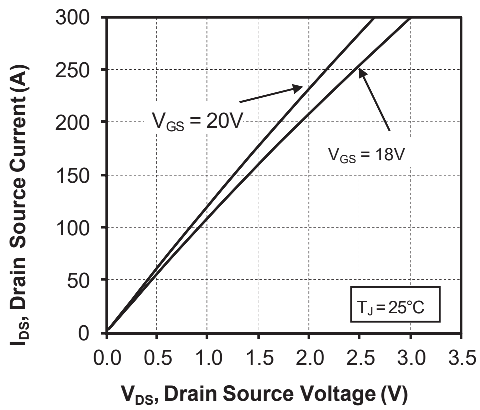


Figure 1-2. Output Characteristics, T_J = 175 °C

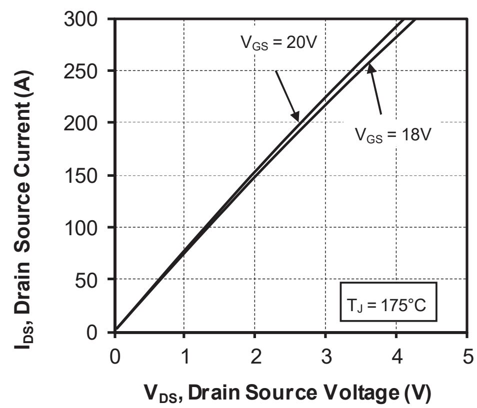


Figure 1-3. Normalized $R_{DS(on)}$ vs. Temperature

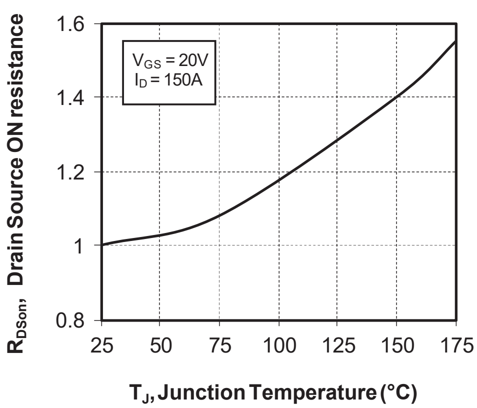


Figure 1-4. Transfer Characteristics

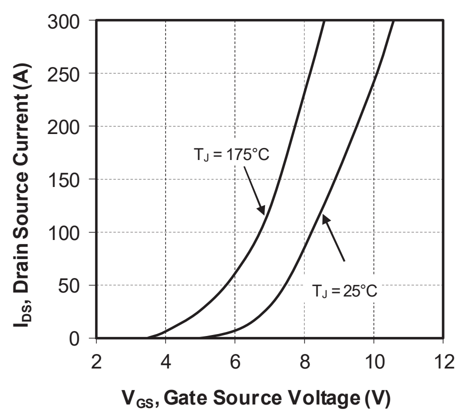


Figure 1-5. Switching Energy vs. R_G

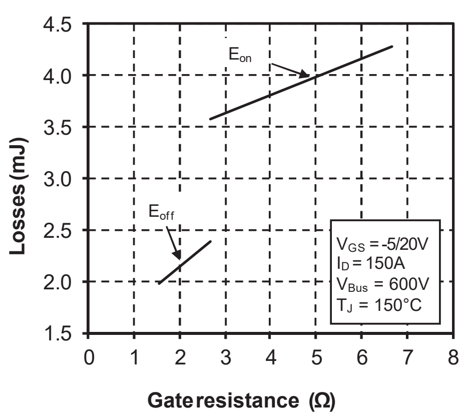
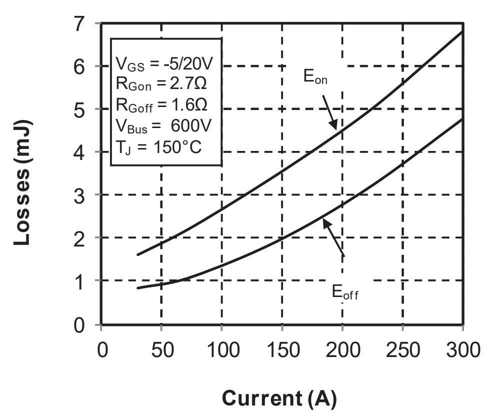
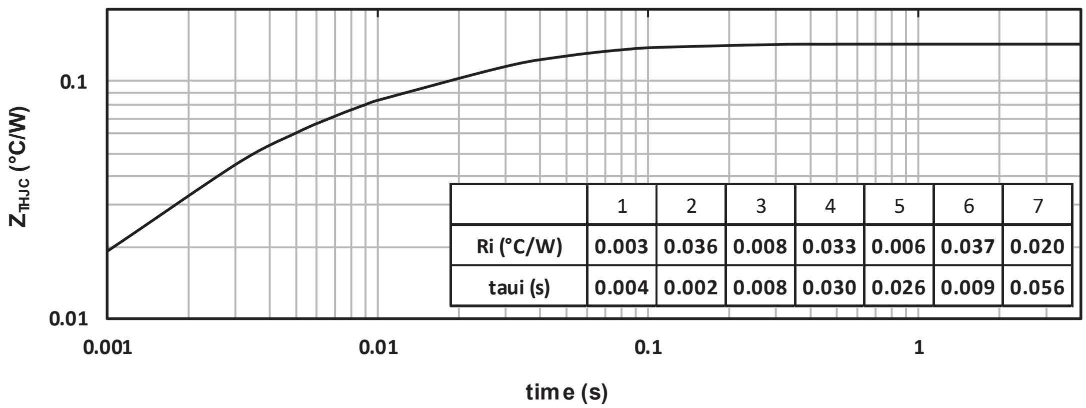


Figure 1-6. Switching Energy vs. Current



© 2025 Microchip Technology Inc. and its subsidiaries

Figure 1-7. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.003	0.036	0.008	0.033	0.006	0.037	0.020
taui (s)	0.004	0.002	0.008	0.030	0.026	0.009	0.056

Figure 1-8. Capacitance vs. Drain Source Voltage

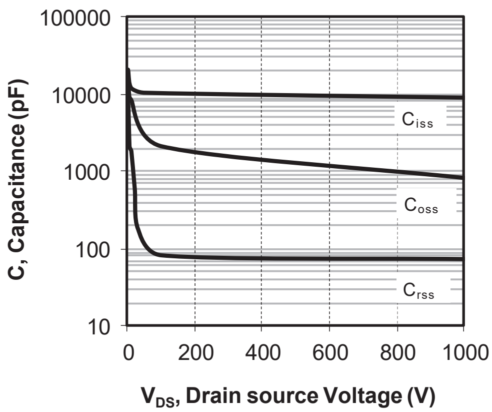


Figure 1-9. Gate Charge vs. Gate Source Voltage

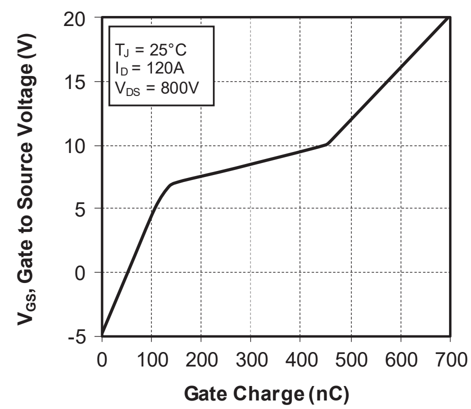


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

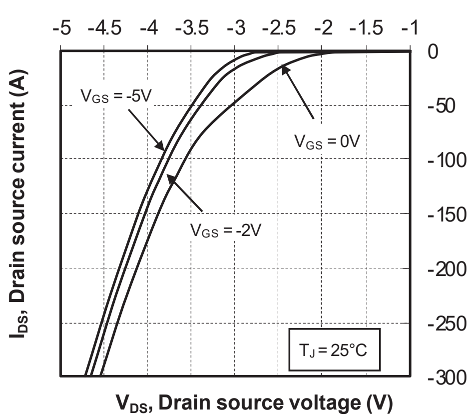
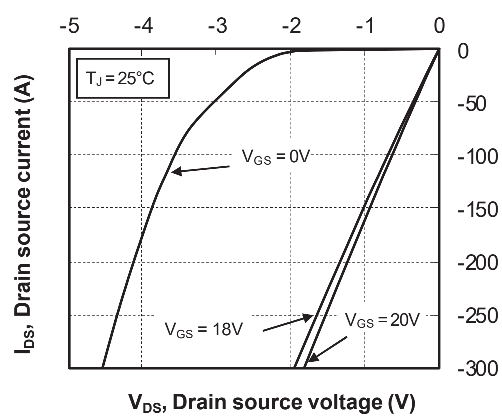


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C



© 2025 Microchip Technology Inc. and its subsidiaries

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

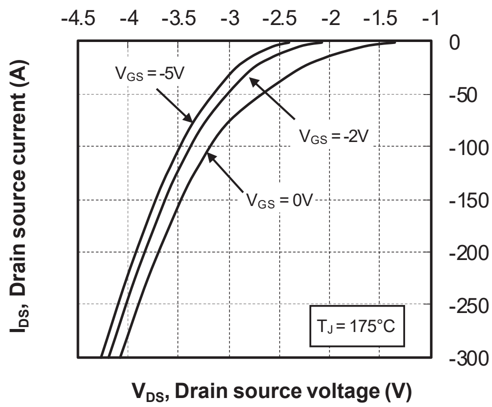


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

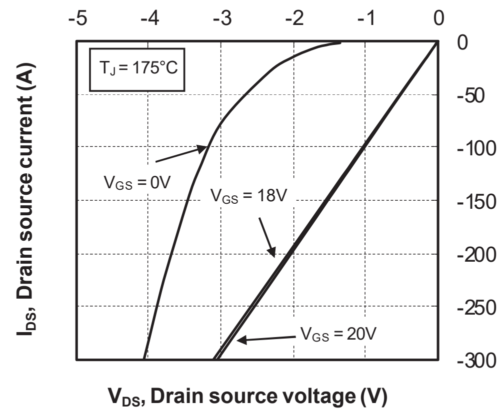
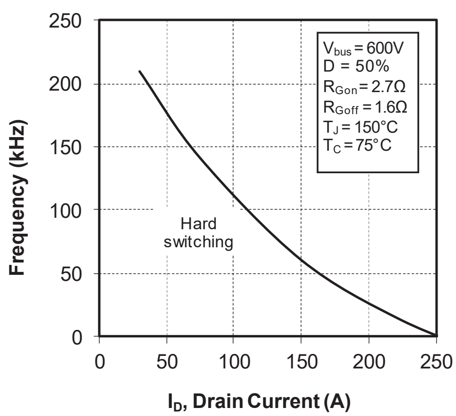


Figure 1-14. Operating Frequency vs. Drain Current



© 2025 Microchip Technology Inc. and its subsidiaries

1.5. Typical IGBT and Diode Performance Curve

This section shows the typical IGBT and diode performance curves of the MSCSMG120ANPCM11TPAG device.

Figure 1-15. Output Characteristics

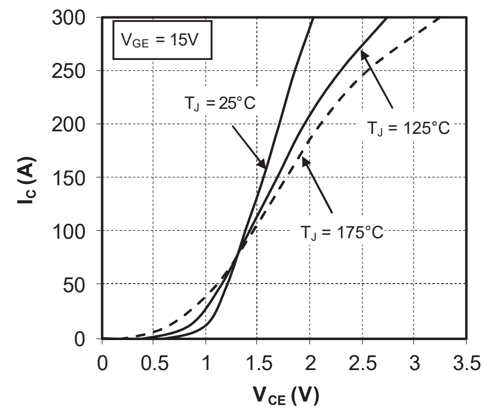


Figure 1-16. Output Characteristics

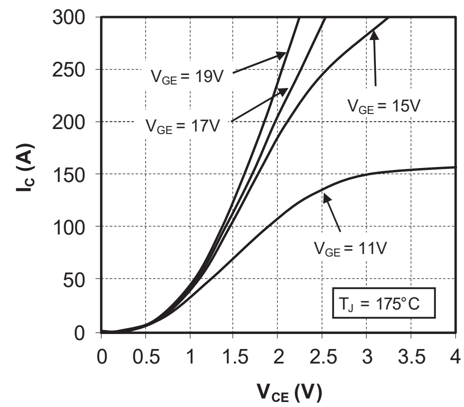


Figure 1-17. Switching Losses vs. Gate Resistance

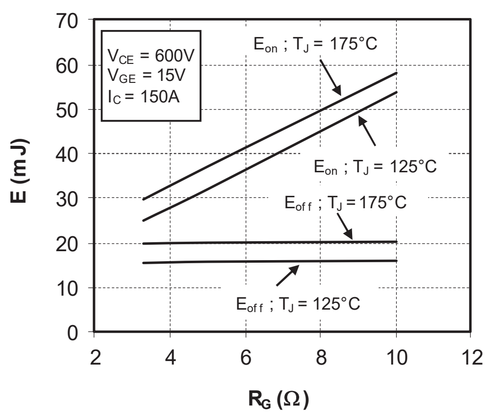


Figure 1-18. Switching Losses vs. Collector Current

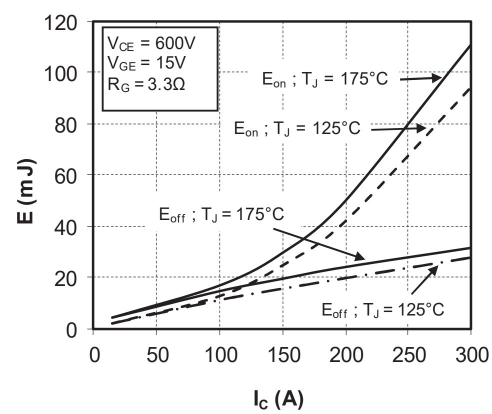
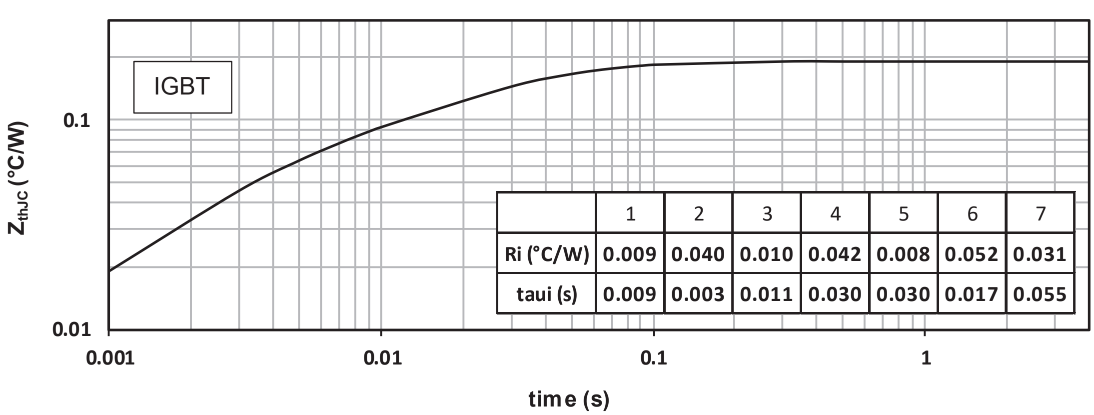


Figure 1-19. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.009	0.040	0.010	0.042	0.008	0.052	0.031
taui (s)	0.009	0.003	0.011	0.030	0.030	0.017	0.055

© 2025 Microchip Technology Inc. and its subsidiaries

Figure 1-20. Operating Frequency vs. Collector Current

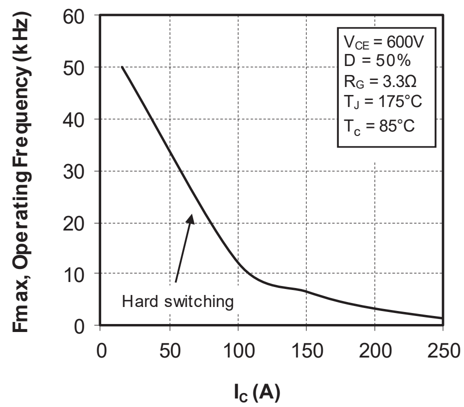


Figure 1-21. Gate Charge vs. Gate Emitter Voltage

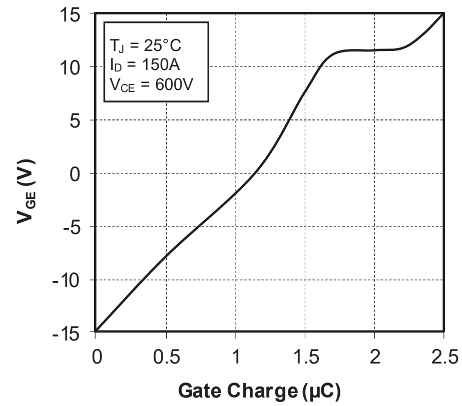


Figure 1-22. Transfer Characteristics

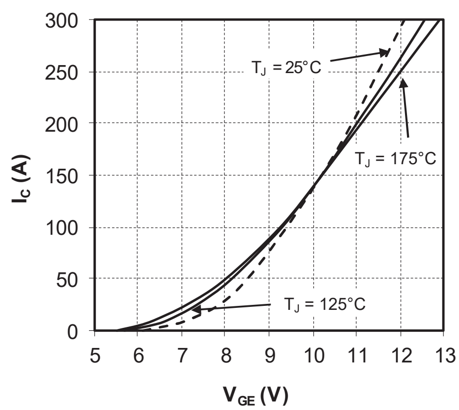


Figure 1-23. Capacity Characteristics

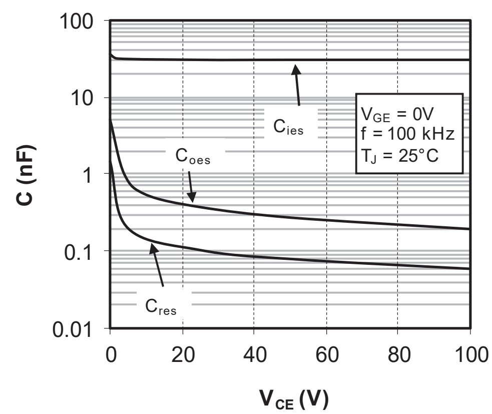


Figure 1-24. Reverse Bias Safe Operating Area

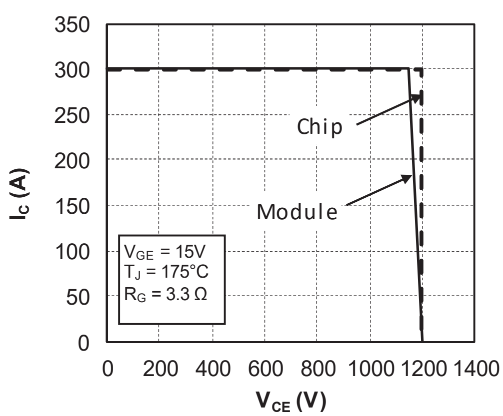
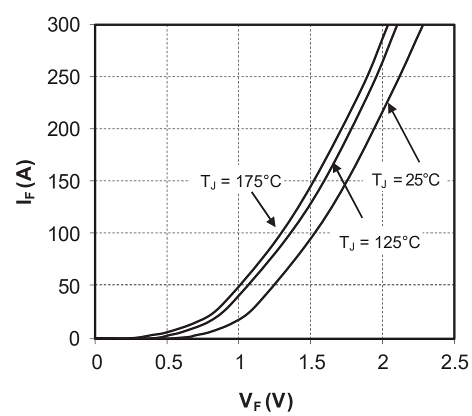


Figure 1-25. Forward Characteristics



© 2025 Microchip Technology Inc. and its subsidiaries

Figure 1-26. Switching Losses vs. Gate Resistance

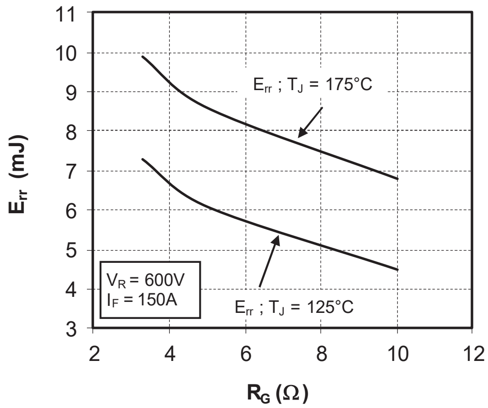


Figure 1-27. Switching Losses vs. Forward Current

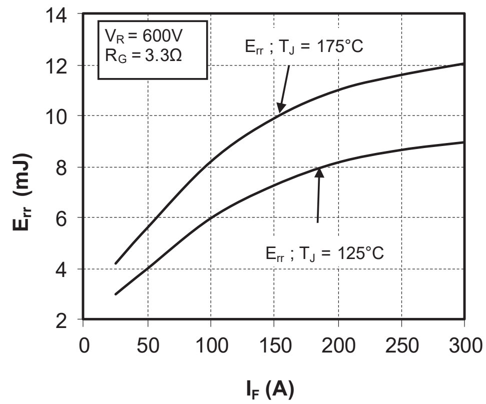
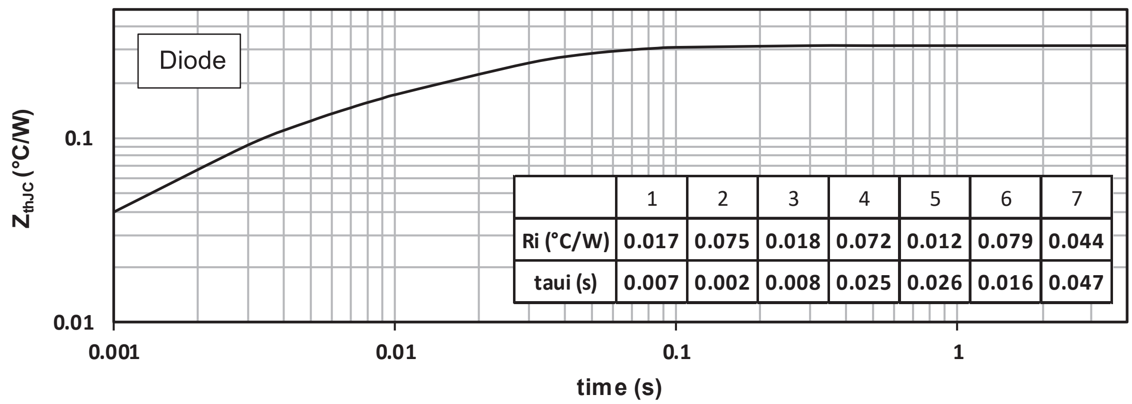


Figure 1-28. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.017	0.075	0.018	0.072	0.012	0.079	0.044
taui (s)	0.007	0.002	0.008	0.025	0.026	0.016	0.047

© 2025 Microchip Technology Inc. and its subsidiaries

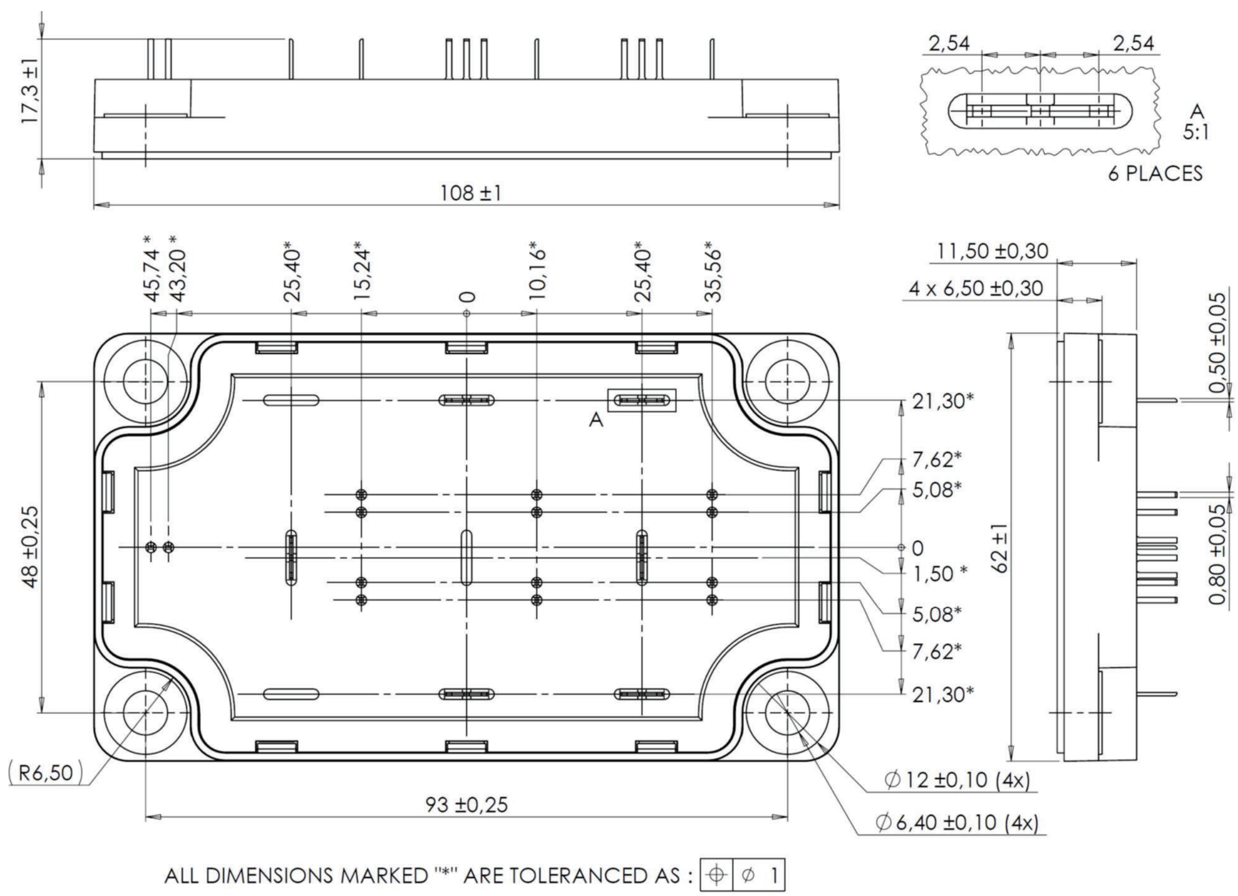
2. Package Specifications

The following section shows the package specification of the MSCSMG120ANPCM11TPAG device.

2.1. Package Outline

The following figure shows the package outline drawing of the MSCSMG120ANPCM11TPAG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: For more information, see the latest application note on mounting instruction for SP6-P power modules, available on the Microchip website.

© 2025 Microchip Technology Inc. and its subsidiaries

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	11/2025	Initial Revision

© 2025 Microchip Technology Inc. and its subsidiaries

Microchip Information

Trademarks

The "Microchip" name and logo, the "M" logo, and other names, logos, and brands are registered and unregistered trademarks of Microchip Technology Incorporated or its affiliates and/or subsidiaries in the United States and/or other countries ("Microchip Trademarks"). Information regarding Microchip Trademarks can be found at https://www.microchip.com/en-us/about/legal-information/microchip-trademarks.

ISBN: 979-8-3371-2288-5

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip products are strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

© 2025 Microchip Technology Inc. and its subsidiaries