ANPC Power Module

MSCSMG170ANPCM15TPAG

Product Overview

The MSCSMG170ANPCM15TPAG device is an ANPC 1700V, Silicon Carbide (SiC) power module.

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

Figure 1. Electrical Diagram

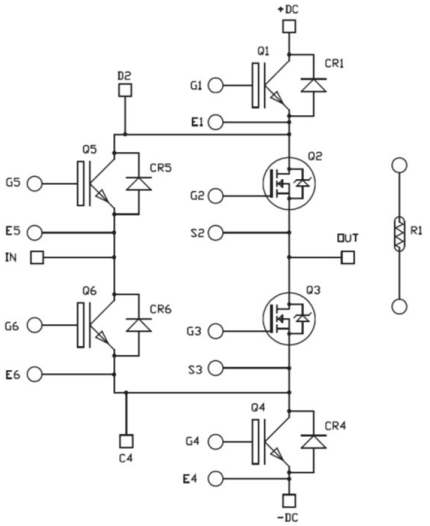
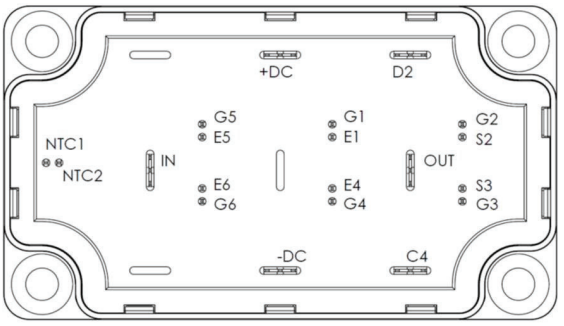


Figure 2. Pinout Location



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 MSCSMG170ANPCM15TPAG device has the following key features:

- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- IGBT3
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 20 kHz
  - Soft recovery parallel diodes
  - Low diode VF
- Low stray inductance
- Internal thermistor for temperature monitoring
- AlN substrate for improved thermal performance

Benefits

The MSCSMG170ANPCM15TPAG 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 MSCSMG170ANPCM15TPAG device has the following applications:

- AC/DC converter (ANPC hybrid configuration)

1. Electrical Specifications

The following sections show the electrical specifications of the MSCSMG170ANPCM15TPAG device.

1.1. SiC MOSFET Characteristics (per SiC MOSFET)

The following table lists the absolute maximum ratings of the MSCSMG170ANPCM15TPAG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-source voltage		1700	V
I_D	Continuous drain current	T_C = 25 °C	179	A
		T_C = 80 °C	142	
I_{DM}	Pulsed drain current		360	
V_{GS}	Gate-source voltage		–10/23	V
$R_{DS(on)}$	Drain-source ON resistance		15	mΩ
P_D	Power dissipation	T_C = 25 °C	843	W

The following table lists the electrical characteristics of the MSCSMG170ANPCM15TPAG 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} = 1700V		—	30	300	µA
$R_{DS(on)}$	Drain–source ON resistance	V_{GS} = 20V I_D = 90A	T_J = 25°C	—	11.7	15	mΩ
			T_J = 175°C	—	20.8	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 7.5 mA		1.8	3.2	—	V
I_{GSS}	Gate–source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	300	nA

The following table lists the dynamic characteristics of the MSCSMG170ANPCM15TPAG 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		—	9900	—	pF
C_{oss}	Output capacitance			—	450	—	
C_{rss}	Reverse transfer capacitance			—	30	—	
Q_g	Total gate charge	V_{GS} = –5/20V V_{Bus} = 850V I_D = 90A		—	534	—	nC
Q_{gs}	Gate-source charge			—	147	—	
Q_{gd}	Gate-drain charge			—	81	—	
$t_{d(on)}$	Turn-on delay time	V_{GS} = –5/20V; T_J = 150°C V_{Bus} = 900V I_D = 150A R_{Gon} = 1.6Ω; R_{Goff} = 0.9Ω		—	24	—	ns
t_r	Rise time			—	17	—	
$t_{d(off)}$	Turn-off delay time			—	35	—	
t_f	Fall time			—	19	—	
E_{on}	Turn-on energy	V_{GS} = –5/+20V V_{Bus} = 900V I_D = 150A R_{Gon} = 1.6Ω R_{Goff} = 0.9Ω	T_J = 150°C	—	3.9	—	mJ
E_{off}	Turn-off energy		T_J = 150°C	—	0.45	—	
R_{Gint}	Internal gate resistance			—	1.95	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.178	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSMG170ANPCM15TPAG 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} = 90A	—	3.7	—	V
		V_{GS} = −5V; I_{SD} = 90A	—	3.9	—	
t_{rr}	Reverse recovery time	I_{SD} = 90A; V_{GS} = −5V V_R = 900V; di_F/dt = 3000 A/µs	—	27	—	ns
Q_{rr}	Reverse recovery charge		—	1950	—	nC
I_{rr}	Reverse recovery current		—	138	—	A

1.2. IGBT3 and Si Diode Parameters (per IGBT and diode)

The following table lists the absolute maximum ratings of the MSCSMG170ANPCM15TPAG device.

Table 1-5. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{CES}	Collector-emitter voltage		1700	V
I_C	Continuous collector current	T_C = 25°C	180	A
		T_C = 100°C	100	
I_{CM}	Pulsed collector current	T_C = 25°C	200	
V_{GE}	Gate-emitter voltage		±20	V
P_D	Power dissipation	T_C = 25 °C	780	W

The following table lists the electrical characteristics of the MSCSMG170ANPCM15TPAG 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} = 1700V		—	—	50	µA
$V_{CE(sat)}$	Collector emitter saturation voltage	V_{GE} = 15V I_C = 100A	T_J = 25°C	—	2	2.4	V
			T_J = 125°C	—	2.4	—	
$V_{GE(th)}$	Gate threshold voltage	V_{GE} = V_{CE}; I_C = 4 mA		5.2	5.8	6.5	V
I_{GES}	Gate–emitter leakage current	V_{GE} = 20V; V_{CE} = 0V		—	—	600	nA

The following table lists the dynamic characteristics (per IGBT) of the MSCSMG170ANPCM15TPAG 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 = 1 MHz		—	9	—	nF
C_{oes}	Output capacitance			—	0.36	—	
C_{res}	Reverse transfer capacitance			—	0.3	—	
Q_G	Gate charge	V_{GE} = ±15V; V_{CE} = 900V; I_C = 100A		—	1.2	—	µC
$t_{d(on)}$	Turn-on delay time	V_{GS} = ±15V V_{Bus} = 900V I_C = 100A R_G = 4.7Ω; T_J = 125°C		—	400	—	ns
t_r	Rise time			—	50	—	
$t_{d(off)}$	Turn-off delay time			—	800	—	
t_f	Fall time			—	300	—	
E_{on}	Turn-on switching energy	V_{GE} = ±15V	T_J = 125°C	—	32	—	mJ
E_{off}	Turn-off switching energy	V_{Bus} = 900V I_C = 100A R_G = 4.7Ω	T_J = 125°C	—	31	—	
R_{Gint}	Internal gate resistance			—	7.5	—	Ω
I_{sc}	Short circuit data	V_{GE} ≤15V ; V_{Bus} = 900V ; t_p ≤ 10 µs ; T_J = 125°C		—	400	—	A
R_{thJC}	Junction-to-case thermal resistance			—	—	0.16	°C/W

The following table lists the diode ratings and characteristics of the MSCSMG170ANPCM15TPAG device.

Table 1-8. Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	1700	V
I_{RM}	Reverse leakage current	V_R = 1700 V		—	—	50	µA
I_F	DC forward current	Tc = 100°C		—	100	—	A
V_F	Diode forward voltage	I_F = 100A V_{GE} = 0V	T_J = 25°C	—	1.8	2.2	V
			T_J = 125°C	—	1.9	—	
t_{rrm}	Reverse recovery time	I_F = 100A V_R = 900V di/dt = 1170 A/µs	T_J = 25°C	—	420	—	ns
			T_J = 125°C	—	525	—	
Q_{rr}	Reverse recovery charge		T_J = 25°C	—	27	—	µC
			T_J = 125°C	—	43	—	
E_{rr}	Reverse recovery energy		T_J = 25°C	—	13	—	mJ
			T_J = 125°C	—	22	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.29	°C/W

1.3. Package and Temperature Sensor Characteristics

The following table lists the thermal and package characteristics of the MSCSMG170ANPCM15TPAG 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 MSCSMG170ANPCM15TPAG 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	—	%

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.

1.4. Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSMG170ANPCM15TPAG device.

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

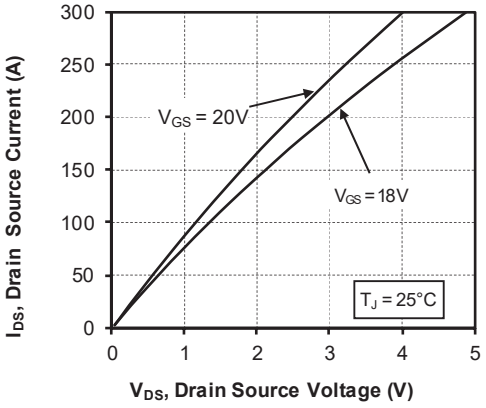


Figure 1-2. Output Characteristics, T_J = 175 °C

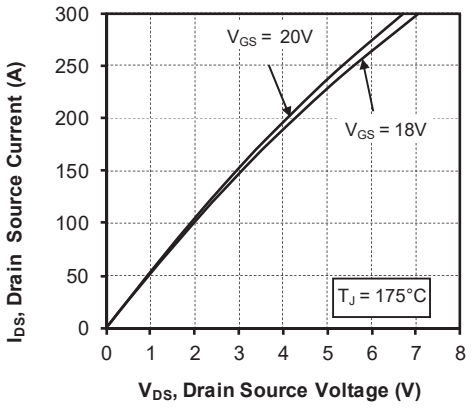


Figure 1-3. Normalized $R_{DS(on)}$ vs. Temperature

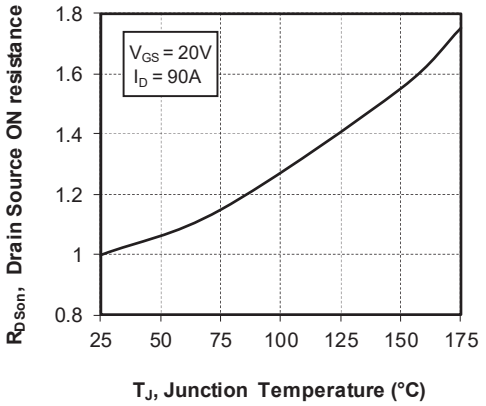


Figure 1-4. Transfer Characteristics

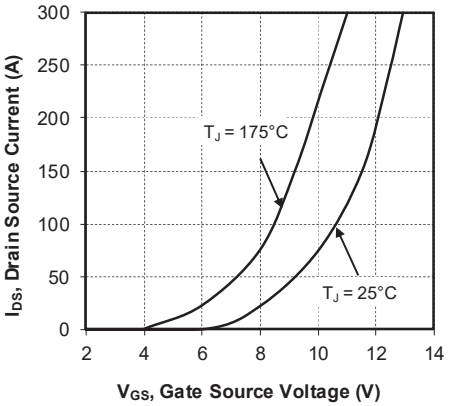


Figure 1-5. Switching Energy vs. R_G

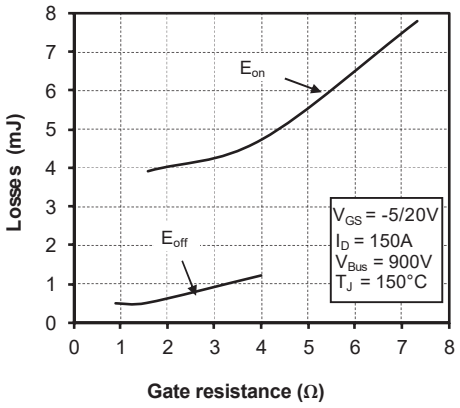


Figure 1-6. Switching Energy vs. Current

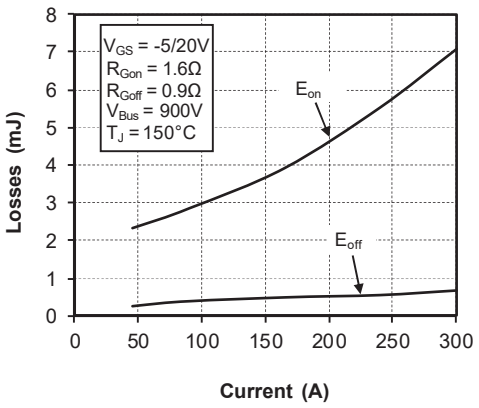
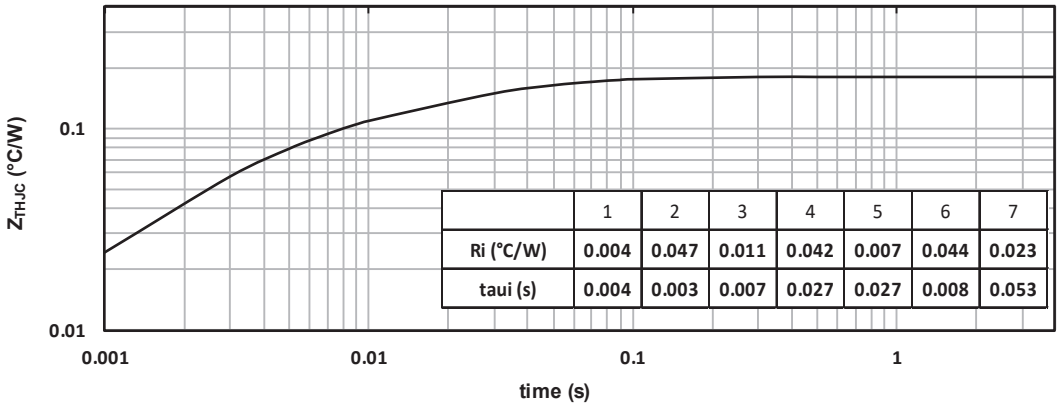


Figure 1-7. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.004	0.047	0.011	0.042	0.007	0.044	0.023
taui (s)	0.004	0.003	0.007	0.027	0.027	0.008	0.053

Figure 1-8. Capacitance vs. Drain Source Voltage

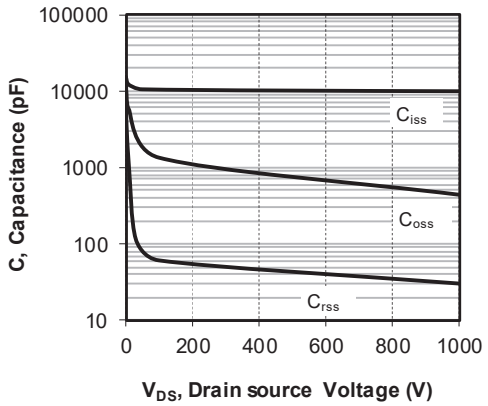


Figure 1-9. Gate Charge vs. Gate Source Voltage

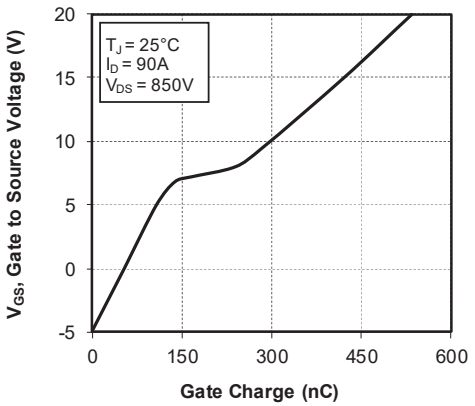


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

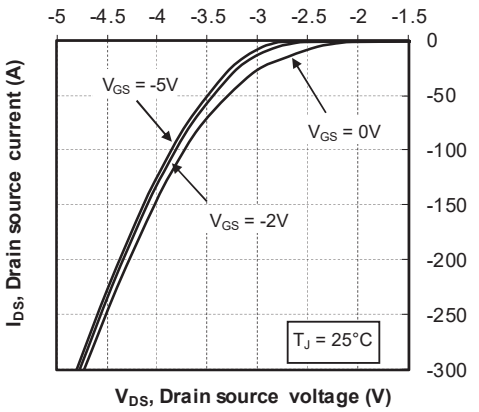


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

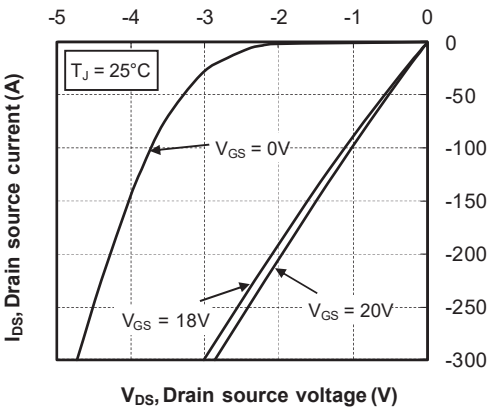


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

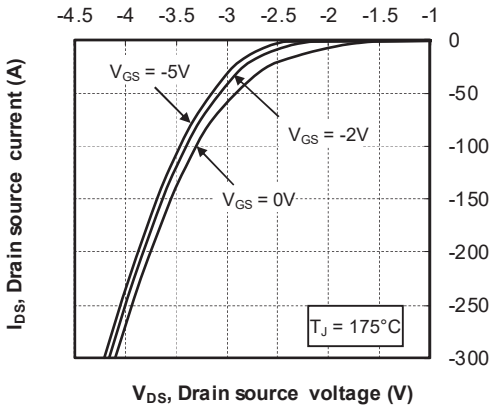


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

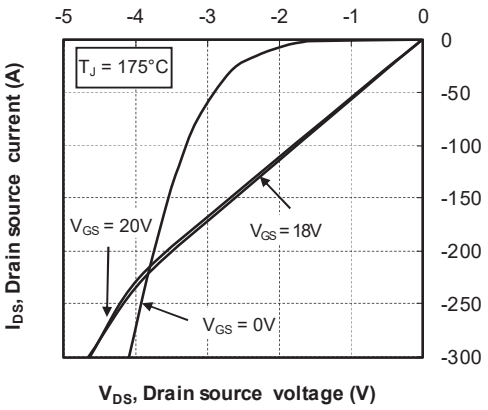
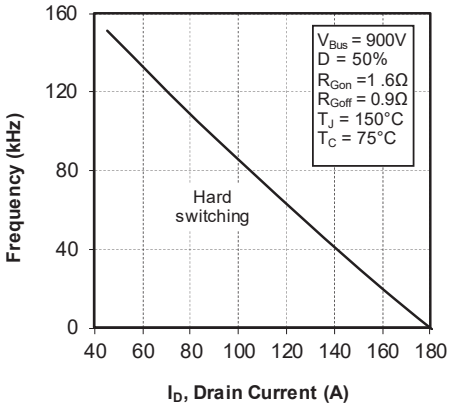


Figure 1-14. Operating Frequency vs. Drain Current



1.5. Typical IGBT and Diode Performance Curve

This section shows the typical IGBT and diode performance curves of the MSCSMG170ANPCM15TPAG device.

Figure 1-15. Output Characteristics, V_{GE} = 15V

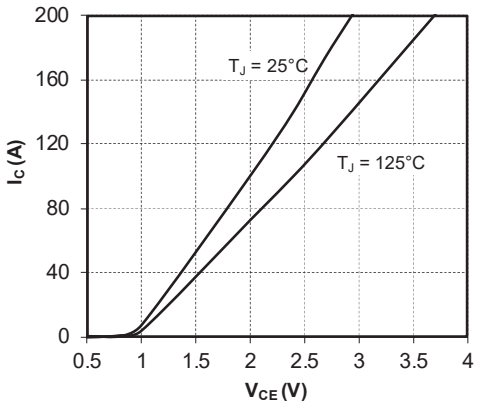


Figure 1-16. Output Characteristics

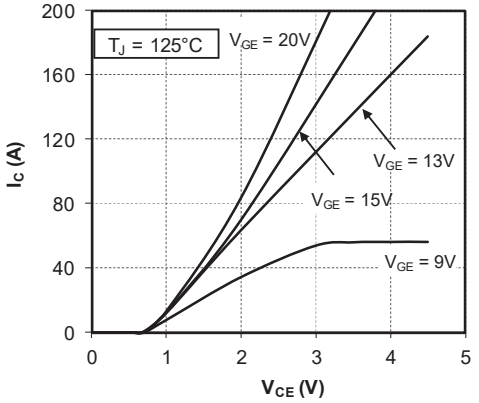


Figure 1-17. Transfer Characteristics

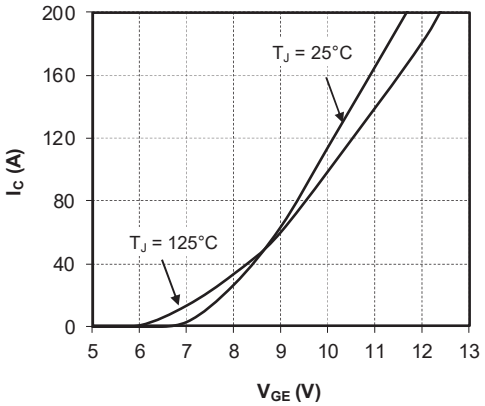


Figure 1-18. Energy Losses vs. Collector Current

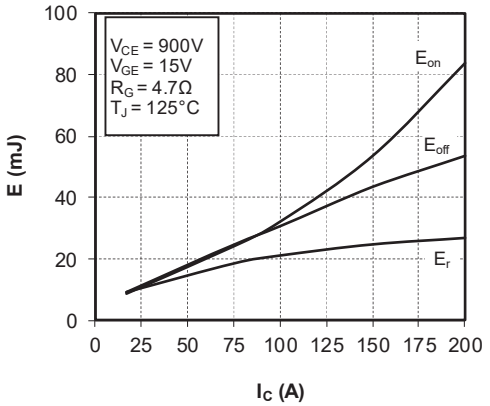


Figure 1-19. Switching Energy Losses vs. Gate Resistance

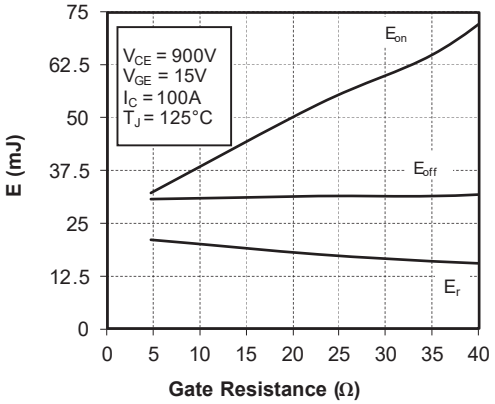
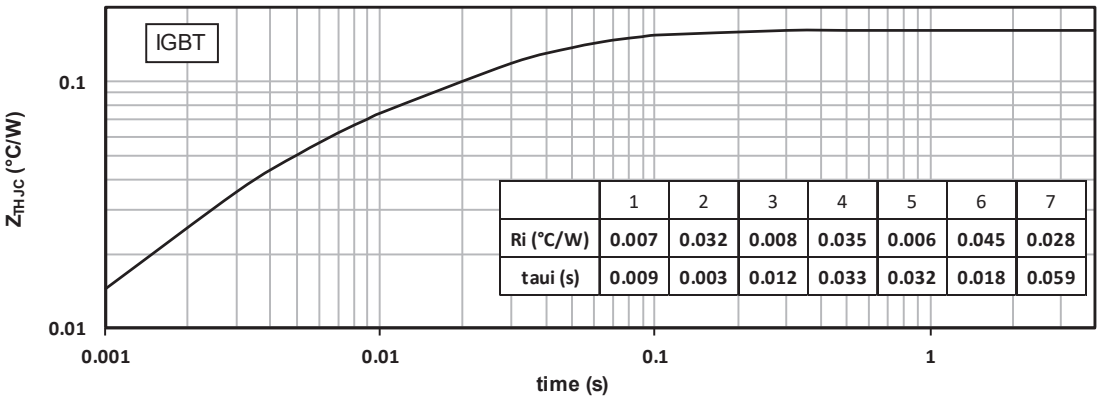


Figure 1-20. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.007	0.032	0.008	0.035	0.006	0.045	0.028
taui (s)	0.009	0.003	0.012	0.033	0.032	0.018	0.059

Figure 1-21. Operating Frequency vs. Collector Current

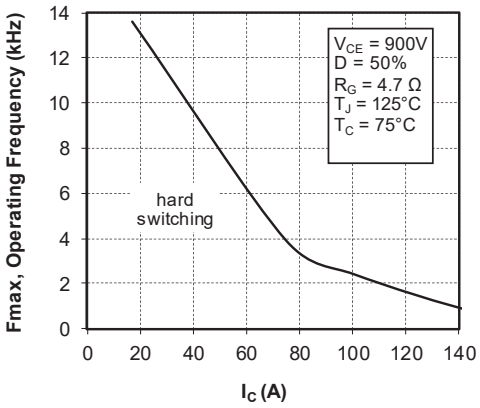


Figure 1-22. Diode Characteristic

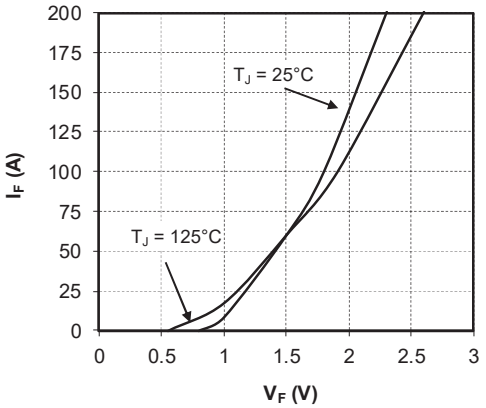
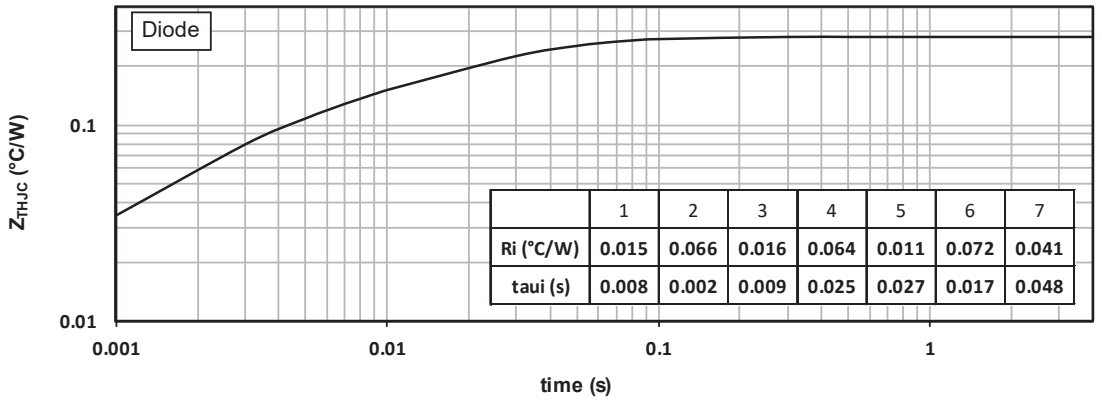


Figure 1-23. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.015	0.066	0.016	0.064	0.011	0.072	0.041
taui (s)	0.008	0.002	0.009	0.025	0.027	0.017	0.048

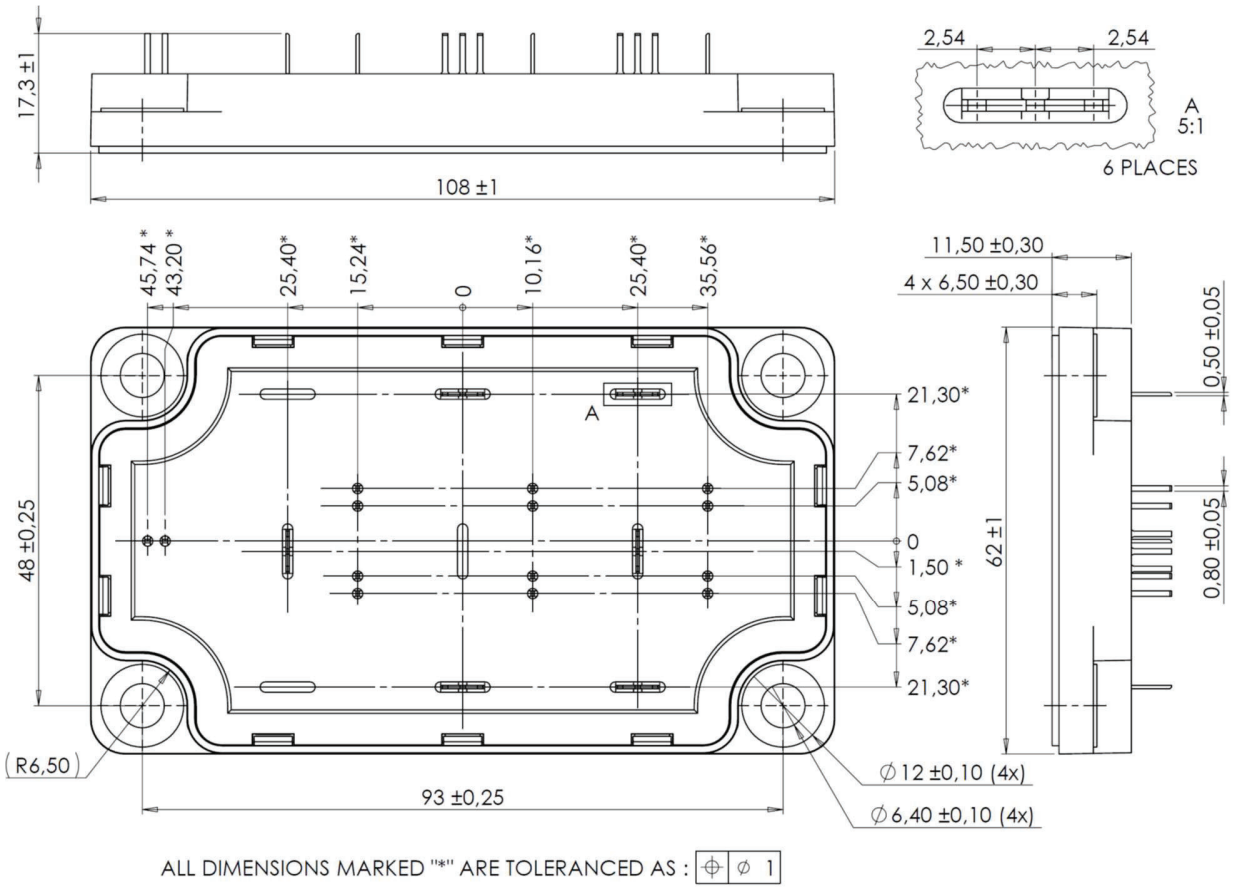
2. Package Specifications

The following section shows the package specification of the MSCSMG170ANPCM15TPAG device.

2.1. Package Outline

The following figure shows the package outline drawing of the MSCSMG170ANPCM15TPAG 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.

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

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- 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.