

Product Overview

The APTGX300HR120G is a T-type power module combining a 1200V, 300A Insulated Gate Bipolar Transistor (IGBT) 7 phase leg and a 650V, 200A Insulated Gate Bipolar Transistor (IGBT) 3 dual common emitter.

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

Figure 1. Electrical Diagram

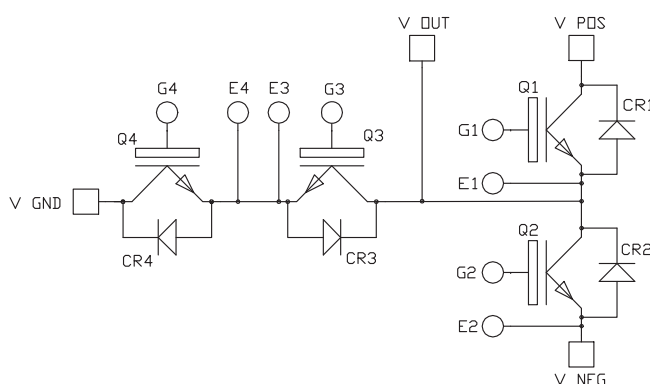
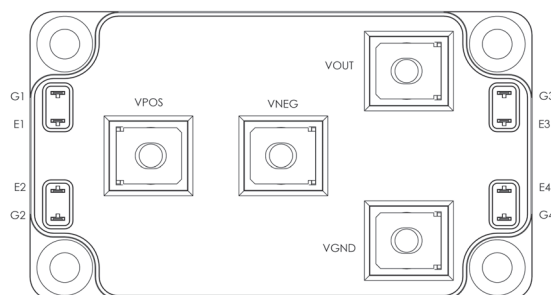


Figure 2. Pinout Location



Note:

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



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

Features

The APTGX300HR120G device has the following key features:

- IGBT 7 (Phase leg)
- IGBT 3 (Dual common emitter)
 - Low-voltage drop
 - Low-leakage current
- Very low-stray inductance
- Kelvin emitter for easy drive
- M5 power connectors
- Al₂O₃ substrate and copper base plate

Benefits

The APTGX300HR120G device has the following benefits:

- High efficiency converter
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS compliant

Potential Applications

The APTGX300HR120G device has the following applications:

- Welding converters
- Switched-mode power supplies
- Uninterruptible power supplies
- Electric Vehicle (EV) motor and traction drive

1. Electrical Specifications

The following sections show the electrical specifications of the APTGX300HR120G device.

1.1 IGBT 7 Characteristics (Per IGBT): Phase Leg

The following table lists the absolute maximum ratings (per IGBT) of the IGBT 7.

Table 1-1. Absolute Maximum Ratings: IGBT 7 (Phase Leg)

Symbol	Parameter	Maximum Ratings	Unit
V_{CES}	Collector-emitter voltage	1200	V
I_C	Continuous collector current	$T_C = 25\text{ }^{\circ}\text{C}$ 415	A
		$T_C = 80\text{ }^{\circ}\text{C}$ 300	
I_{CM}	Pulsed collector current, t_p limited by $T_{J(max)}$	600	
V_{GE}	Gate-emitter voltage	± 20	V
	Transient gate-emitter voltage	± 25	
P_D	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$ 1020	W

The following table lists the electrical characteristics (per IGBT) of the IGBT 7.

Table 1-2. Electrical Characteristics: IGBT 7 (Phase Leg)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{CES}	Zero gate voltage collector current	$V_{GE} = 0V$; $V_{CE} = 1200V$	—	—	24	μA
$V_{CE(sat)}$	Collector emitter saturation voltage	$V_{GE} = 15V$ $I_C = 300A$	$T_J = 25\text{ }^{\circ}\text{C}$	—	1.55	V
			$T_J = 125\text{ }^{\circ}\text{C}$	—	1.7	
			$T_J = 175\text{ }^{\circ}\text{C}$	—	1.77	
$V_{GE(th)}$	Gate threshold voltage	$V_{GE} = V_{CE}$; $I_C = 7\text{ mA}$	5.15	5.8	6.45	
I_{GES}	Gate-emitter leakage current	$V_{GE} = 20V$; $V_{CE} = 0V$	—	—	200	nA

The following table lists the dynamic characteristics (per IGBT) of the IGBT 7.

Table 1-3. Dynamic Characteristics: IGBT 7 (Phase Leg)

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C _{ies}	Input capacitance	V _{GE} = 0V V _{CE} = 25V f = 100 kHz		—	60	—	nF
C _{oes}	Output capacitance			—	0.76	—	
C _{res}	Reverse transfer capacitance			—	0.22	—	
Q _G	Gate charge	V _{GE} = ±15V V _{CE} = 600V I _C = 300A		—	5	—	μC
T _{d(on)}	Turn-on delay time	V _{GE} = ±15V V _{Bus} = 600V I _C = 300A R _G = 1.8Ω	T _J = 25 °C	—	195	—	ns
			T _J = 125 °C	—	200	—	
			T _J = 175 °C	—	205	—	
T _r	Rise time		T _J = 25 °C	—	70	—	
			T _J = 125 °C	—	72	—	
			T _J = 175 °C	—	75	—	
T _{d(off)}	Turn-off delay time		T _J = 25 °C	—	422	—	
			T _J = 125 °C	—	500	—	
			T _J = 175 °C	—	530	—	
T _f	Fall time		T _J = 25 °C	—	103	—	
			T _J = 125 °C	—	198	—	
			T _J = 175 °C	—	260	—	
E _{on}	Turn-on energy	V _{GE} = ±15V V _{Bus} = 600V I _C = 300A	T _J = 25 °C	—	35.3	—	mJ
		R _G = 1.8Ω di/dt = 3500 A/μs dv/dt = 3900 V/μs	T _J = 125 °C	—	37.7	—	
			T _J = 175 °C	—	44.8	—	
E _{off}	Turn-off energy		T _J = 25 °C	—	21.8	—	
		T _J = 125 °C	—	29.4	—		
		T _J = 175 °C	—	36.8	—		
R _{Gint}	Internal gate resistance			—	0.5	—	Ω
I _{sc}	Short circuit data	V _{GE} ≤ 15V V _{Bus} = 800V t _p ≤ 8 μs	T _J = 150 °C	—	1040	—	A
		V _{GE} ≤ 15V V _{Bus} = 800V t _p ≤ 7 μs	T _J = 175 °C	—	980	—	
R _{thJC}	Junction-to-case thermal resistance			—	—	0.147	°C/W

The following table lists the diode characteristics (per diode) of the IGBT 7.

Table 1-4. Diode Characteristics: IGBT 7 (Phase Leg)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{RRM}	Peak repetitive reverse voltage		—	—	1200	V
I_{RM}	Reverse leakage current	$V_R = 1200V$	—	—	16	μA
I_{FRM}	Repetitive forward current, t_p limited by $T_{J(max)}$		—	—	600	A
I^2t	I^2t value	$t_p = 10\text{ ms}$ $V_R = 0V$	$T_J = 125\text{ }^\circ C$ $T_J = 175\text{ }^\circ C$	— —	8390 5110	A^2s
I_F	DC forward current	$T_C = 45\text{ }^\circ C$	$T_J = 175\text{ }^\circ C$	—	300	A
V_F	Diode forward voltage	$I_F = 300A$ $V_{GE} = 0V$	$T_J = 25\text{ }^\circ C$ $T_J = 125\text{ }^\circ C$ $T_J = 175\text{ }^\circ C$	— 1.75 1.6 1.52	2 — —	V
I_{RRM}	Reverse recovery current	$V_{GE} = -15V$ $I_F = 300A$ $V_R = 600V$ $di/dt = 3500\text{ A}/\mu s$	$T_J = 25\text{ }^\circ C$ $T_J = 125\text{ }^\circ C$ $T_J = 175\text{ }^\circ C$	— — —	130 184 214	A
Q_{rr}	Reverse recovery charge		$T_J = 25\text{ }^\circ C$ $T_J = 125\text{ }^\circ C$ $T_J = 175\text{ }^\circ C$	— — —	20.6 43.4 57.2	μC
E_{rr}	Reverse recovery energy		$T_J = 25\text{ }^\circ C$ $T_J = 125\text{ }^\circ C$ $T_J = 175\text{ }^\circ C$	— — —	6.6 14.6 19.8	mJ
R_{thJC}	Junction-to-case thermal resistance		—	—	0.241	$^\circ C/W$

1.2 IGBT 3 Characteristics (Per IGBT): Dual Common Emitter

The following table lists the absolute maximum ratings (per IGBT) of the IGBT 3.

Table 1-5. Absolute Maximum Ratings: IGBT 3 (Dual Common Emitter)

Symbol	Parameter		Maximum Ratings	Unit
V _{CES}	Collector-emitter voltage		650	V
I _C	Continuous collector current	T _C = 25 °C	300	A
		T _C = 80 °C	200	
I _{CM}	Pulsed collector current, t _p limited by T _{J(max)}		400	
V _{GE}	Gate-emitter voltage		±20	V
P _D	Power dissipation	T _C = 25 °C	625	W

The following table lists the electrical characteristics (per IGBT) of the IGBT 3.

Table 1-6. Electrical Characteristics: IGBT 3 (Dual Common Emitter)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{CES}	Zero gate voltage collector current	$V_{GE} = 0V$; $V_{CE} = 650V$	—	—	20	μA
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15V$ $I_C = 200A$	$T_J = 25\text{ }^\circ C$ $T_J = 150\text{ }^\circ C$	— —	1.5 1.7	V
$V_{GE(th)}$	Gate threshold voltage	$V_{GE} = V_{CE}$; $I_C = 3.2\text{ mA}$	5.1	5.8	6.4	
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 IGBT 3.

Table 1-7. Dynamic Characteristics: IGBT 3 (Dual Common Emitter)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C _{ies}	Input capacitance	V _{GE} = 0V V _{CE} = 25V f = 1 MHz	—	12.3	—	nF
C _{oes}	Output capacitance		—	0.8	—	
C _{res}	Reverse transfer capacitance		—	0.4	—	
Q _G	Gate charge	V _{GE} = ±15V V _{CE} = 300V I _C = 200A	—	2.2	—	μC
T _{d(on)}	Turn-on delay time	V _{GE} = ±15V V _{BUS} = 300V I _C = 200A R _G = 2Ω	T _J = 25 °C	—	115	ns
			T _J = 150 °C	—	130	
T _r	Rise time		T _J = 25 °C	—	45	
			T _J = 150 °C	—	50	
T _{d(off)}	Turn-off delay time		T _J = 25 °C	—	225	
			T _J = 150 °C	—	300	
T _f	Fall time		T _J = 25 °C	—	55	
			T _J = 150 °C	—	70	
E _{on}	Turn-on energy	V _{GE} = ±15V V _{BUS} = 300V I _C = 200A R _G = 2Ω di/dt = 2200 A/μs dv/dt = 4000 V/μs	T _J = 25 °C	—	1	mJ
			T _J = 150 °C	—	1.8	
E _{off}	Turn-off energy		T _J = 25 °C	—	5.7	
			T _J = 150 °C	—	7	
R _{Gint}	Internal gate resistance		—	2	—	Ω
I _{sc}	Short circuit data	V _{GE} ≤ 15V V _{BUS} = 360V t _p ≤ 6 μs	T _J = 150 °C	—	1000	A
R _{thJC}	Junction-to-case thermal resistance		—	—	0.24	°C/W

The following table lists the diode characteristics (per diode) of the IGBT 3.

Table 1-8. Diode Characteristics: IGBT 3 (Dual Common Emitter)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V _{RRM}	Peak repetitive reverse voltage		—	—	650	V
I _{RM}	Reverse leakage current	V _R = 650V	—	—	25	μA
I _F	DC forward current	T _C = 25 °C	T _J = 175 °C	—	200	A
V _F	Diode forward voltage	I _F = 200A V _{GE} = 0V	T _J = 25 °C	—	1.6	V
			T _J = 150 °C	—	1.5	
t _{rr}	Reverse recovery time	I _F = 200A V _R = 300V di/dt = 2200 A/μs	T _J = 25 °C	—	130	nS
			T _J = 150 °C	—	225	
Q _{rr}	Reverse recovery charge		T _J = 25 °C	—	9	μC
			T _J = 150 °C	—	19	
E _{rr}	Reverse recovery energy		T _J = 25 °C	—	2.3	mJ
			T _J = 150 °C	—	4.7	
R _{thJC}	Junction-to-case thermal resistance		—	—	0.437	°C/W

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the APTGX300HR120G device.

Table 1-9. 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			4000	—	—	V
d _{creep}	Creepage distance terminal-to-terminal			—	15.3	—	mm
	Creepage distance terminal-to-heatsink			—	15.9	—	
d _{clear}	Clearance distance terminal-to-terminal			—	11.4	—	
	Clearance distance terminal-to-heatsink			—	12.1	—	
R _{CE}	Lead resistance terminal-to-chip	T _C = 25 °C, per switch		—	0.65	—	mΩ
T _J	Operating junction temperature range			–40	—	175	°C
T _{STG}	Storage temperature range			–40	—	125	
T _C	Operating case temperature			–40	—	125	
τ _M	Mounting torque	To heatsink	M6	3	—	5	N.m
		For terminals	M5	2	—	3.5	
Wt	Package weight			—	282	—	g

1.4 Typical IGBT 7 Performance Curve (Phase Leg)

The following figures show the IGBT 7 performance curves of the APTGX300HR120G device.

Figure 1-1. Maximum Thermal Impedance

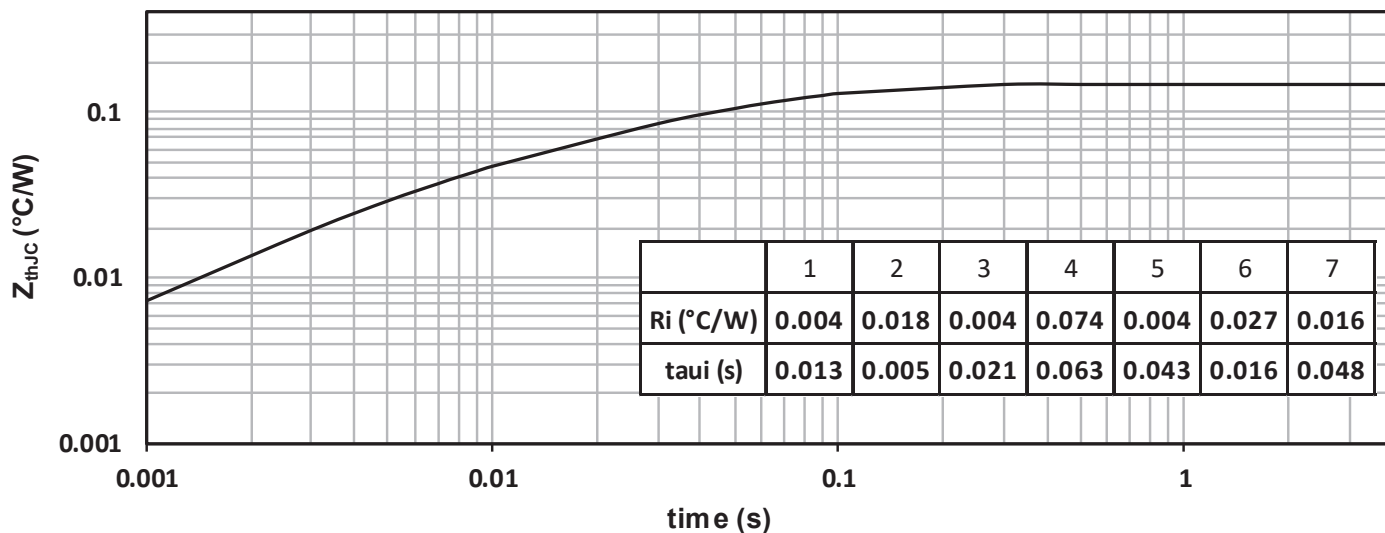


Figure 1-2. Output Characteristics, $V_{GE} = 15\text{V}$

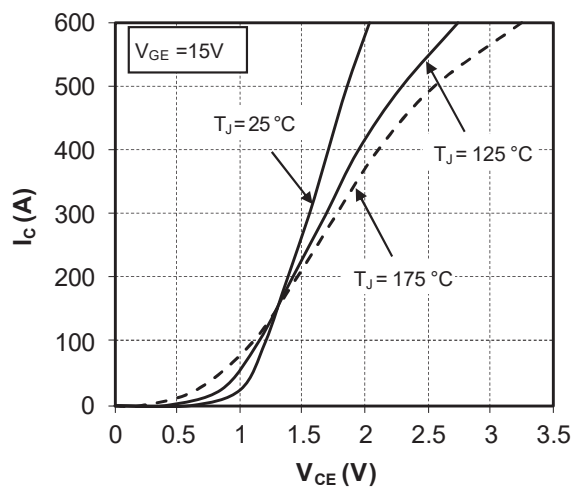


Figure 1-3. Output Characteristics, $T_J = 175^{\circ}\text{C}$

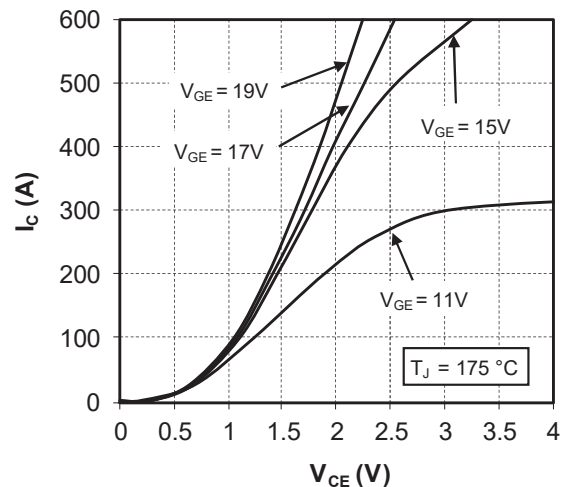


Figure 1-4. Switching Losses vs. Gate Resistance

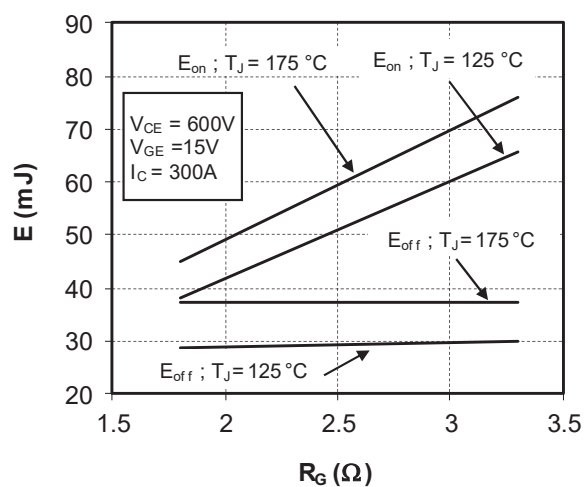


Figure 1-5. Switching Losses vs. Collector Current

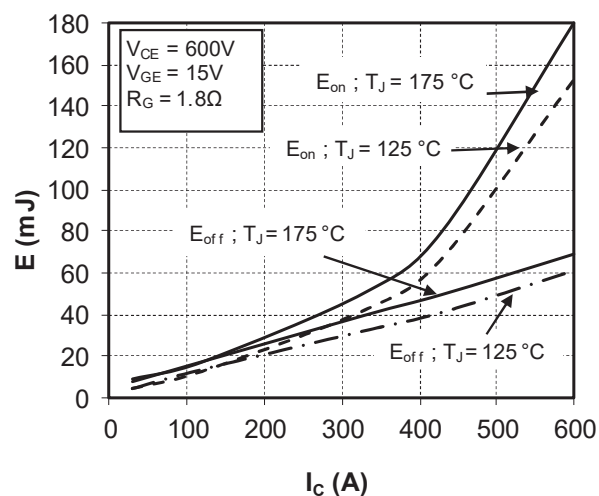


Figure 1-6. Operating Frequency vs. Collector Current

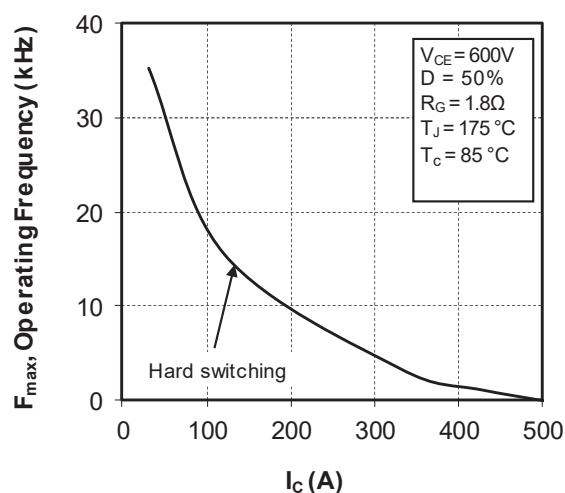


Figure 1-7. Gate Charge Characteristics

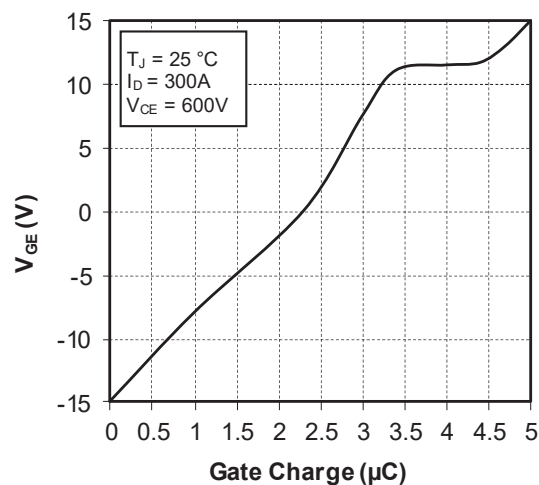


Figure 1-8. Transfer Characteristics

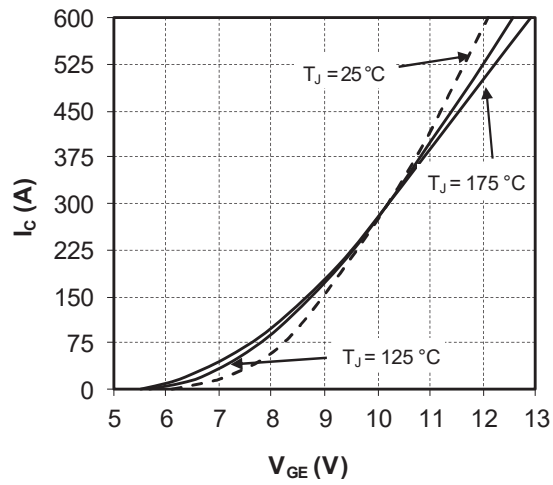


Figure 1-9. Capacity Characteristics

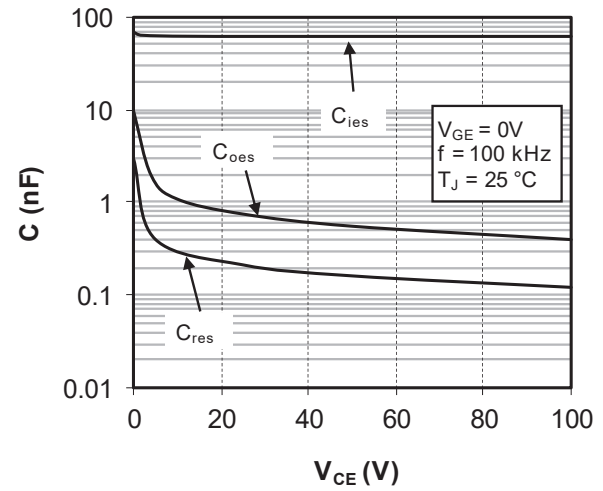
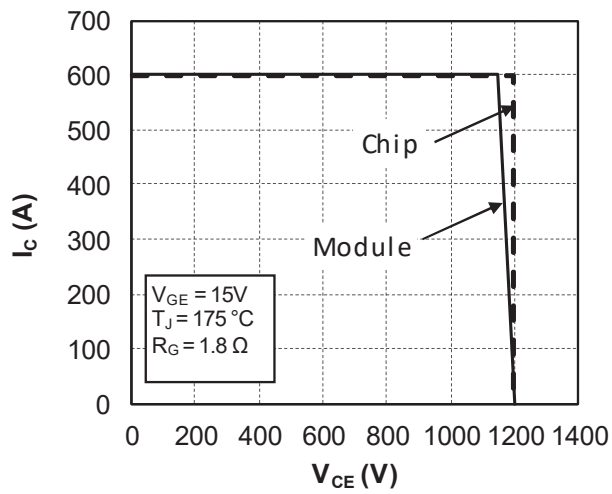


Figure 1-10. Reverse Bias Safe Operating Area



1.5 Typical Diode 7 Performance Curve (Phase Leg)

The following figures show the diode 7 performance curves of the APTGX300HR120G device.

Figure 1-11. Maximum Thermal Impedance

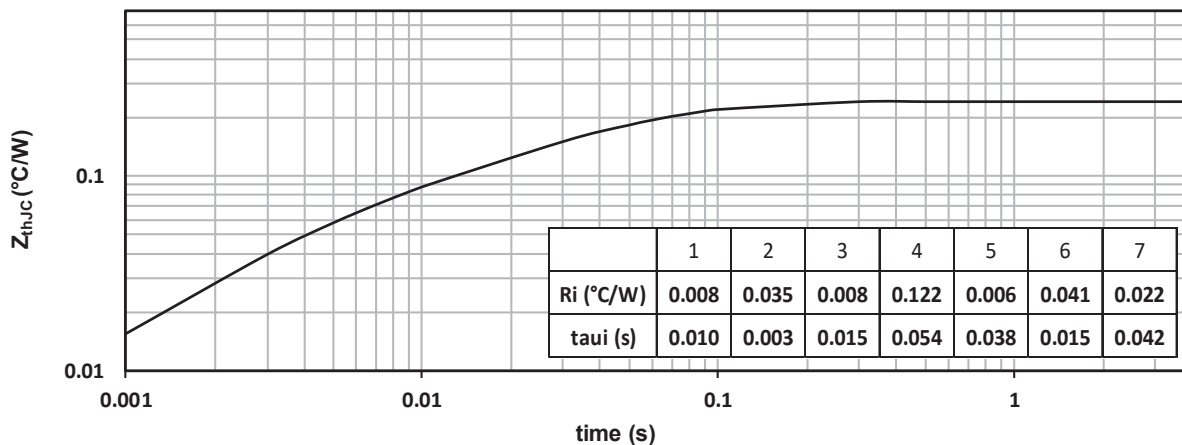


Figure 1-12. Forward Characteristics

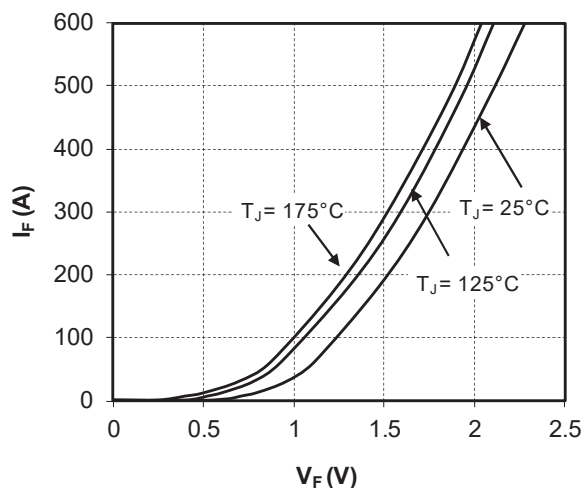


Figure 1-13. Switching Losses vs. Gate Resistance

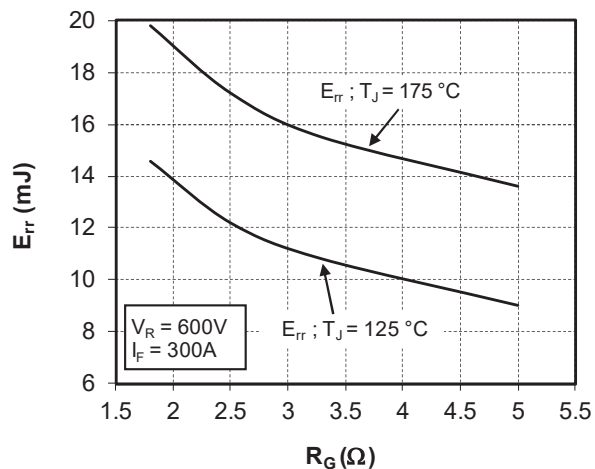
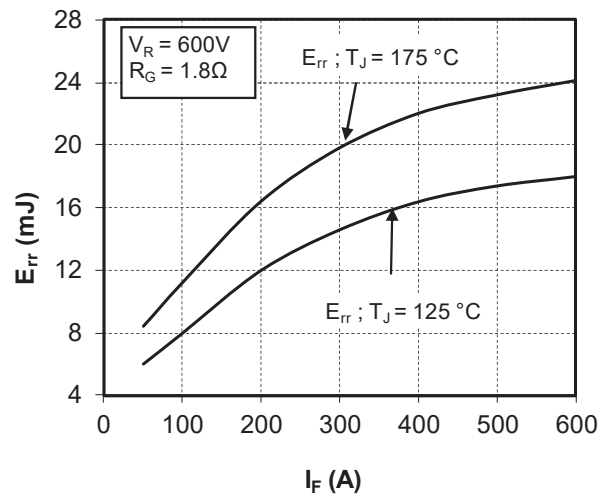


Figure 1-14. Switching Losses vs. Forward Current



1.6 Typical IGBT 3 Performance Curve (Dual Common Emitter)

The following figures show the IGBT 3 performance curves of the APTGX300HR120G device.

Figure 1-15. Maximum Thermal Impedance

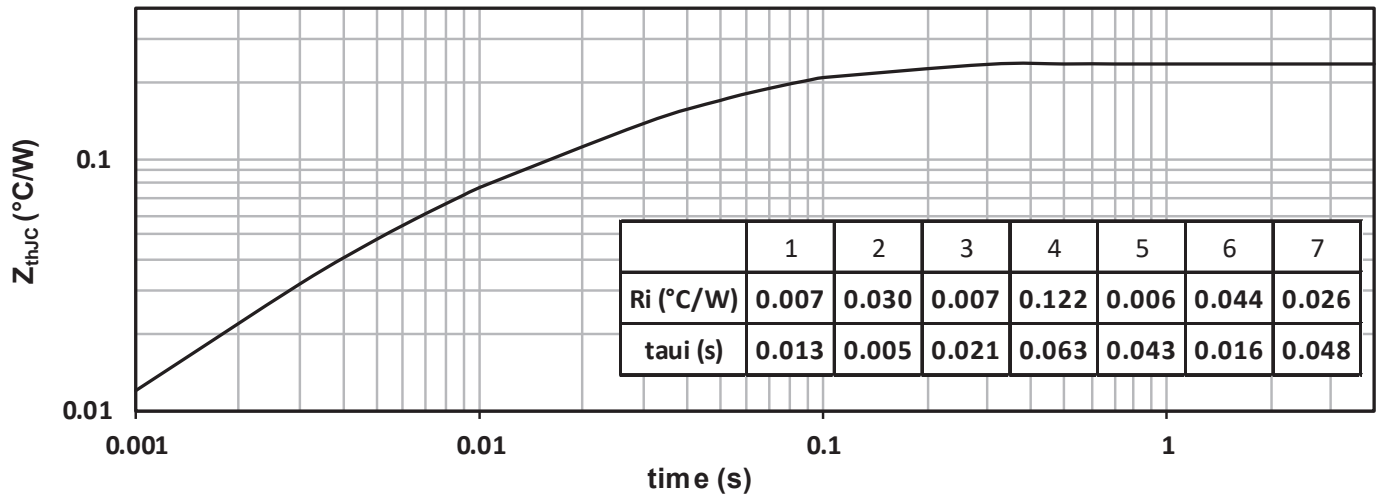


Figure 1-16. Output Characteristics, $V_{GE} = 15V$

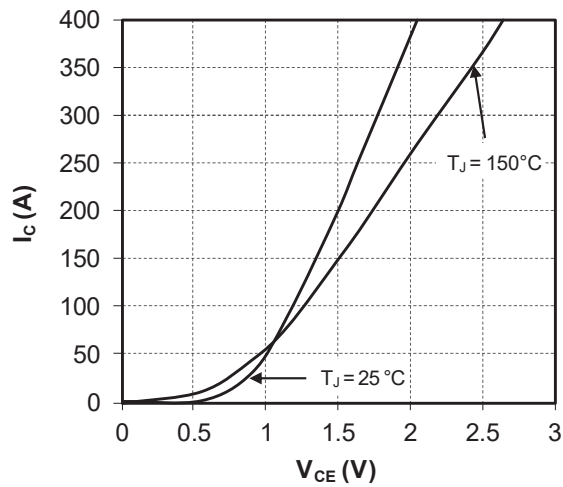


Figure 1-17. Output Characteristics, $T_J = 175^\circ C$

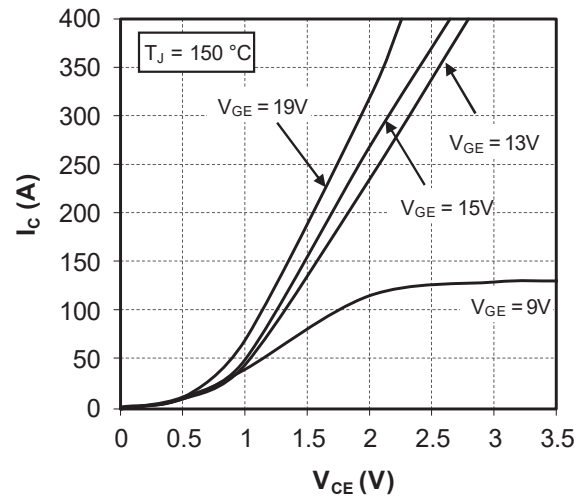


Figure 1-18. Switching Losses vs. Gate Resistance

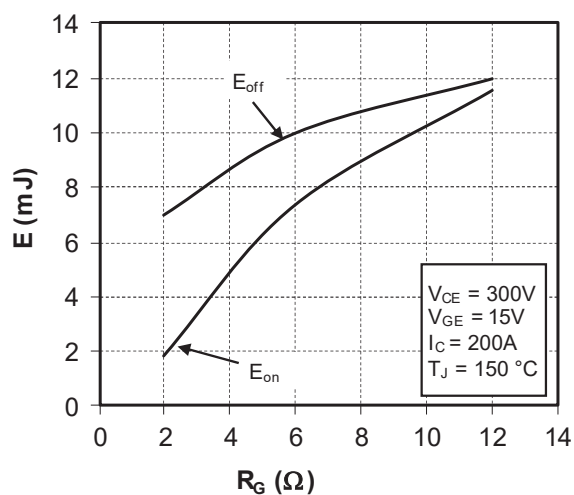


Figure 1-19. Switching Losses vs. Collector Current

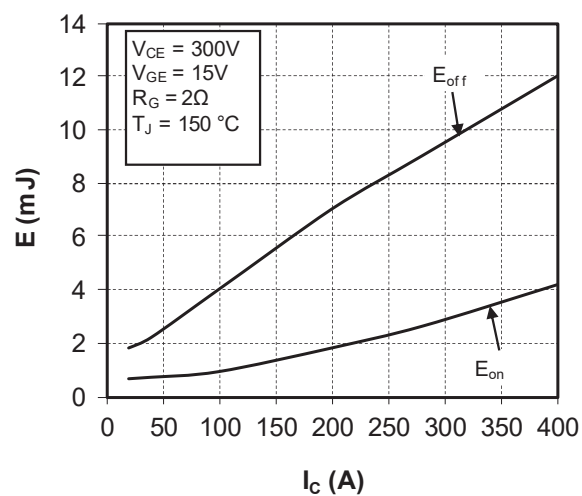


Figure 1-20. Operating Frequency vs. Collector Current

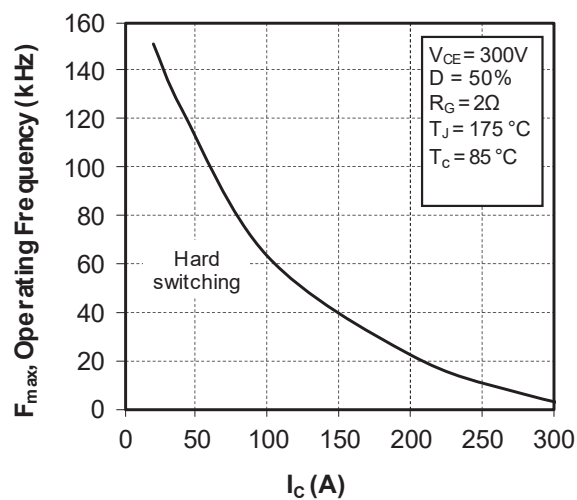


Figure 1-21. Reverse Bias Safe Operating Area

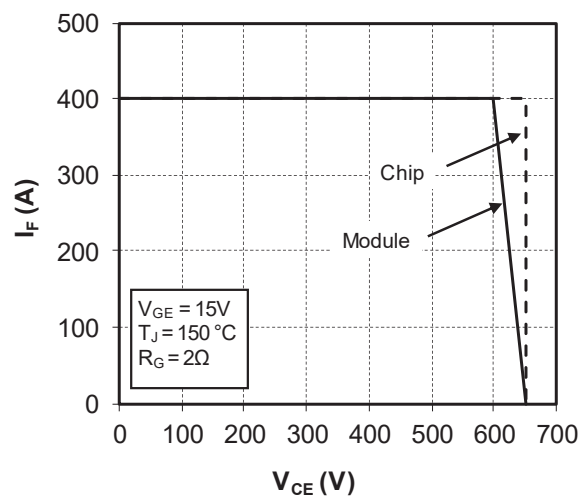
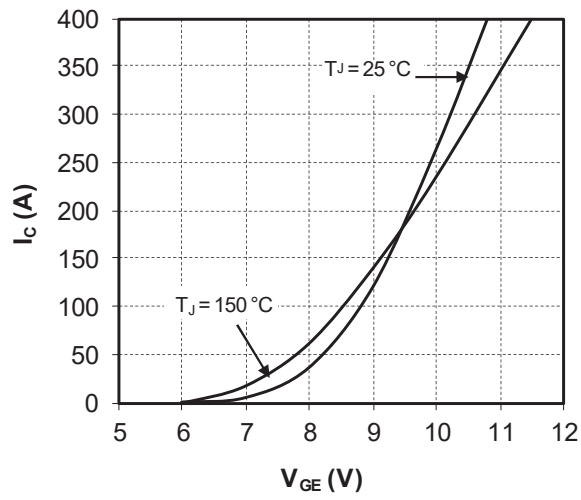


Figure 1-22. Transfer Characteristics



1.7 Typical Diode 3 Performance Curve (Dual Common Emitter)

The following figures show the diode 3 performance curves of the APTGX300HR120G device.

Figure 1-23. Maximum Thermal Impedance

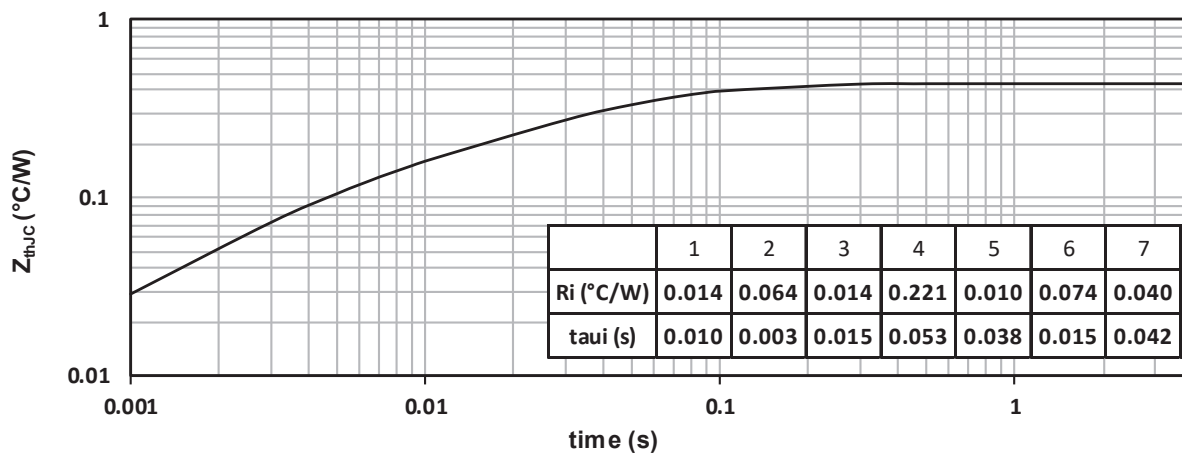


Figure 1-24. Forward Characteristics

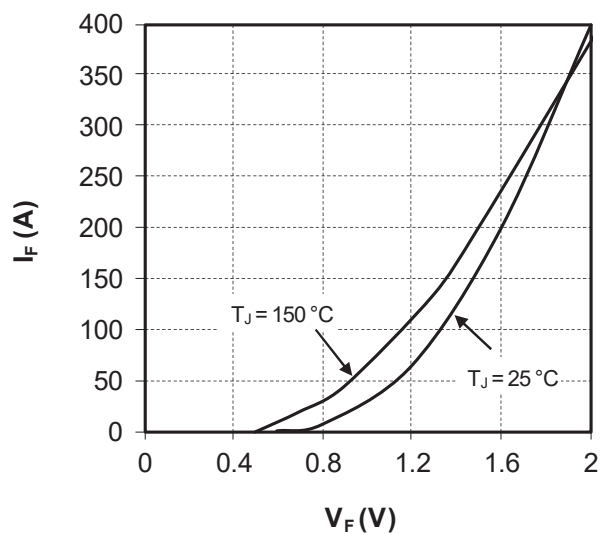


Figure 1-25. Switching Losses vs. Gate Resistance

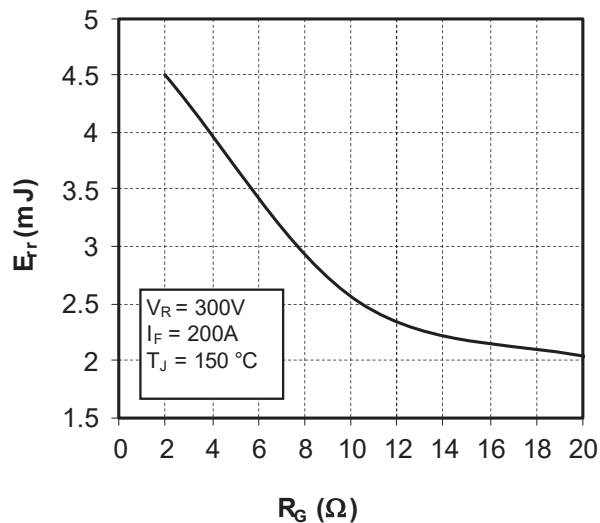
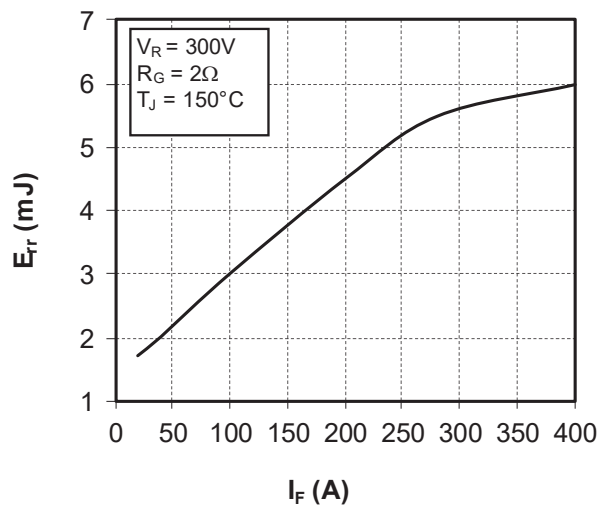


Figure 1-26. Switching Losses vs. Forward Current



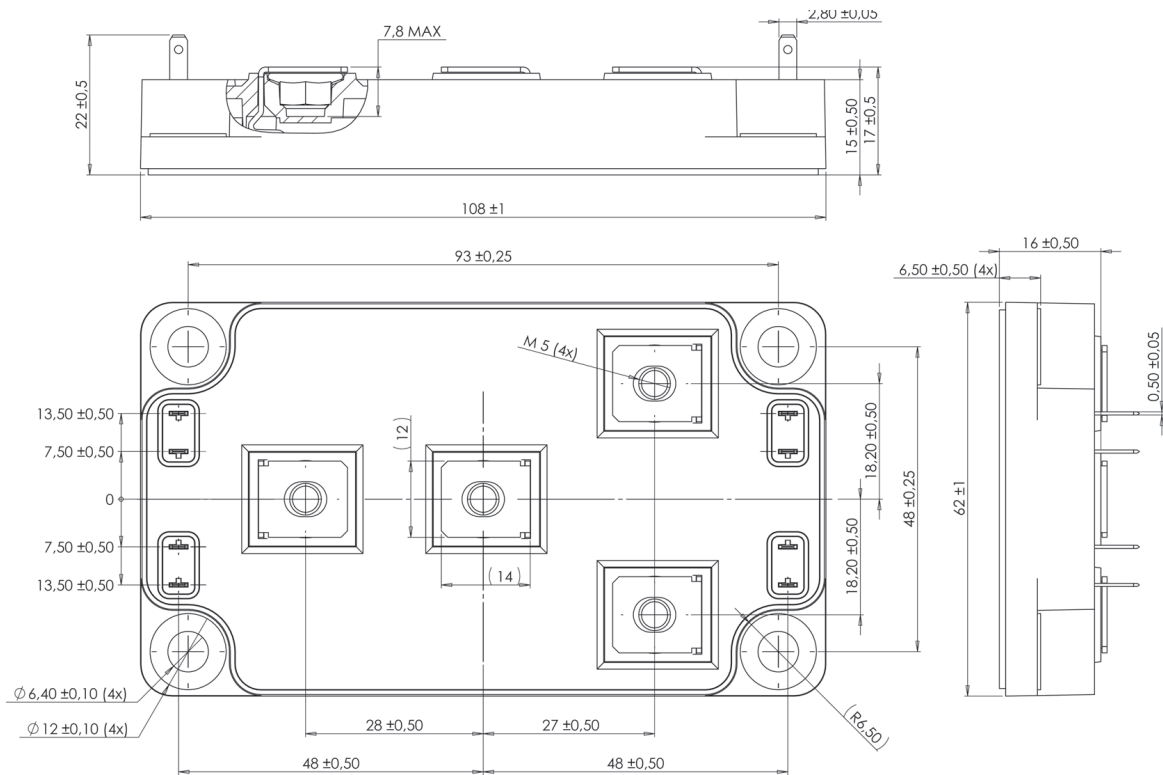
2. Package Specifications

The following section shows the package specification of the APTGX300HR120G device.

2.1 Package Outline

The following figure shows the package outline drawing of the APTGX300HR120G device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: For more information, see [APT0601 - Mounting Instructions for SP6 Power Modules](#).

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	09/2024	Initial revision

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