T-Type IGBT 7 Power Module

APTGX300HR120G

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

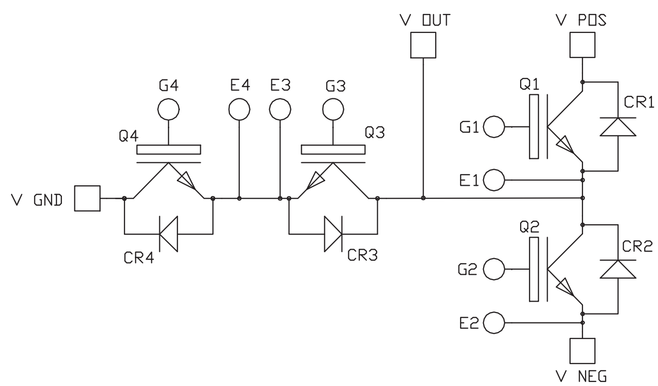
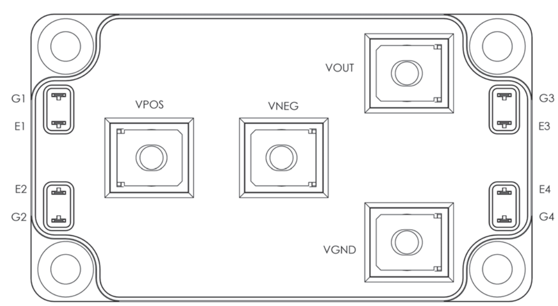


Figure 2. Pinout Location



Note:

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

CAUTION 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
- Al_2O_3 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 °C	415	A
		T_C = 80 °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 °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 °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 = 7 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 R_G = 1.8Ω di/dt = 3500 A/µs dv/dt = 3900 V/µs	T_J = 25 °C	—	35.3	—	mJ
			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 ms V_R = 0V	T_J = 125 °C	—	—	8390	A^2s
			T_J = 175 °C	—	—	5110	
I_F	DC forward current	T_C = 45 °C	T_J = 175 °C	—	300	—	A
V_F	Diode forward voltage	I_F = 300A 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} = -15V I_F = 300A V_R = 600V di/dt =3500 A/µs	T_J = 25 °C	—	130	—	A
			T_J = 125 °C	—	184	—	
			T_J = 175 °C	—	214	—	
Q_{rr}	Reverse recovery charge		T_J = 25 °C	—	20.6	—	µC
			T_J = 125 °C	—	43.4	—	
			T_J = 175 °C	—	57.2	—	
E_{rr}	Reverse recovery energy		T_J = 25 °C	—	6.6	—	mJ
			T_J = 125 °C	—	14.6	—	
			T_J = 175 °C	—	19.8	—	
R_{thJC}	Junction-to-case thermal resistance			—	—	0.241	°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 °C	—	1.5	1.9	V
			T_J = 150 °C	—	1.7	—	
$V_{GE(th)}$	Gate threshold voltage	V_{GE} = V_{CE}; I_C = 3.2 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	2	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.

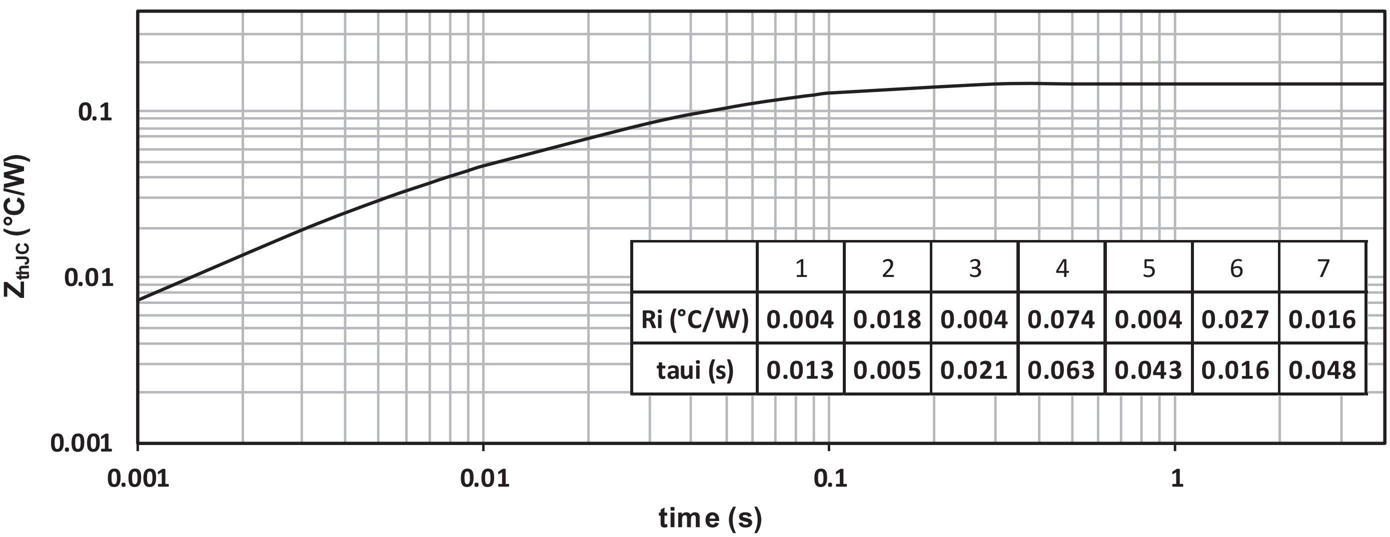
Table 1-9. Thermal and Package Characteristics

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



	1	2	3	4	5	6	7
Ri (°C/W)	**0.004**	**0.018**	**0.004**	**0.074**	**0.004**	**0.027**	**0.016**
taui (s)	**0.013**	**0.005**	**0.021**	**0.063**	**0.043**	**0.016**	**0.048**

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

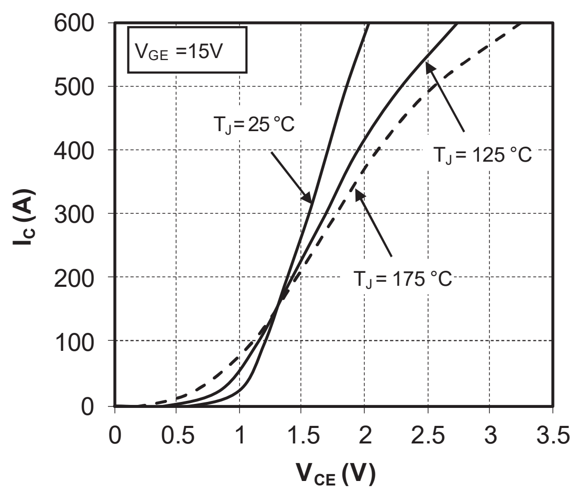


Figure 1-3. Output Characteristics, T_J = 175 °C

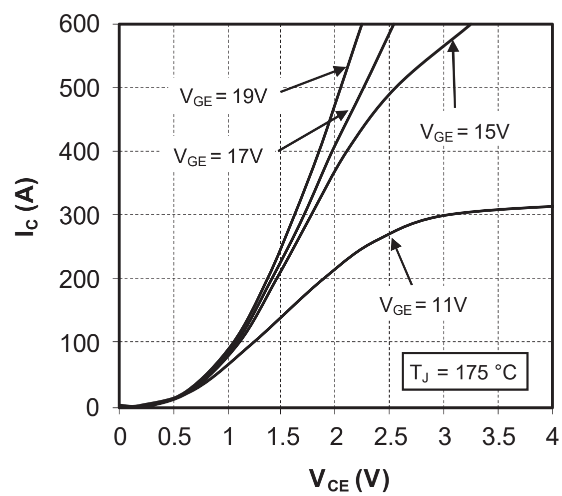


Figure 1-4. Switching Losses vs. Gate Resistance

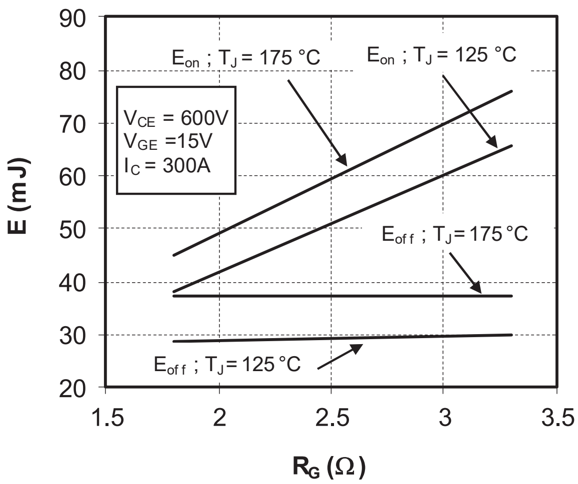


Figure 1-5. Switching Losses vs. Collector Current

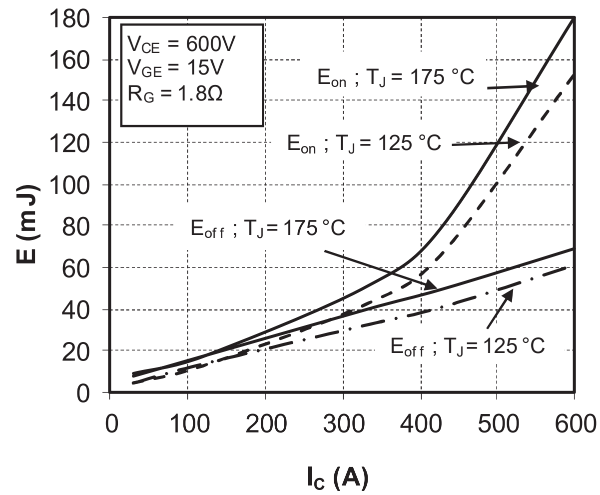


Figure 1-6. Operating Frequency vs. Collector Current

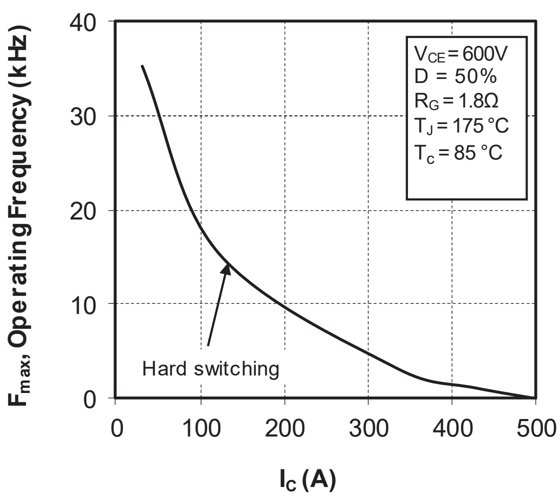


Figure 1-7. Gate Charge Characteristics

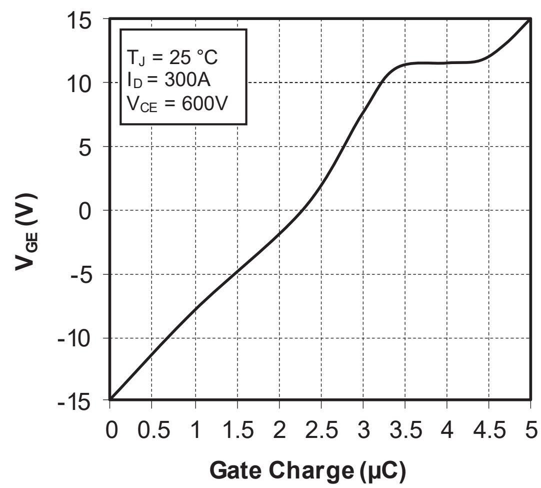


Figure 1-8. Transfer Characteristics

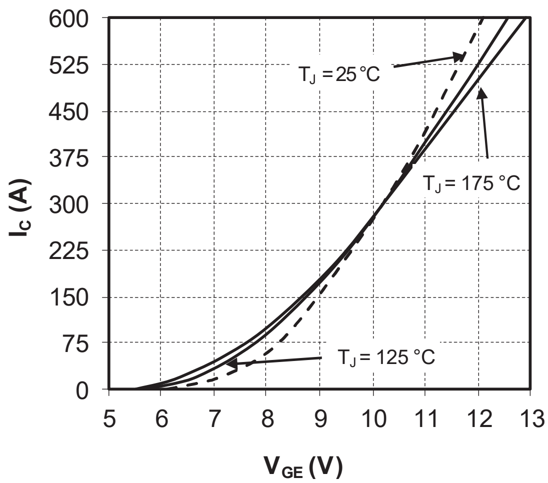


Figure 1-9. Capacity Characteristics

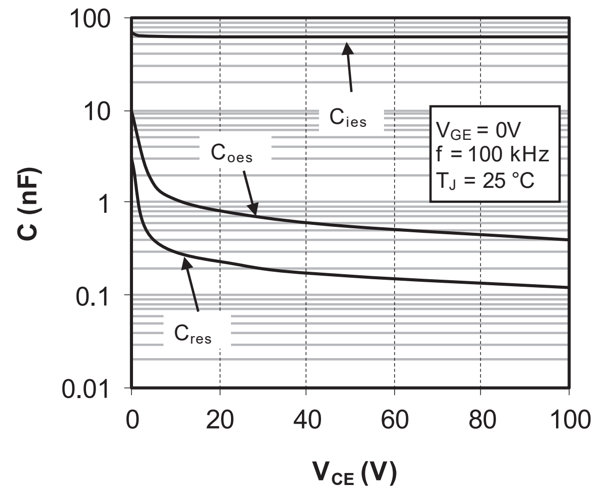
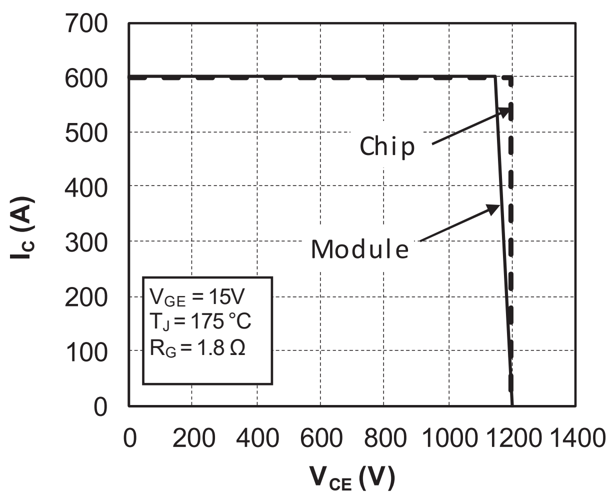


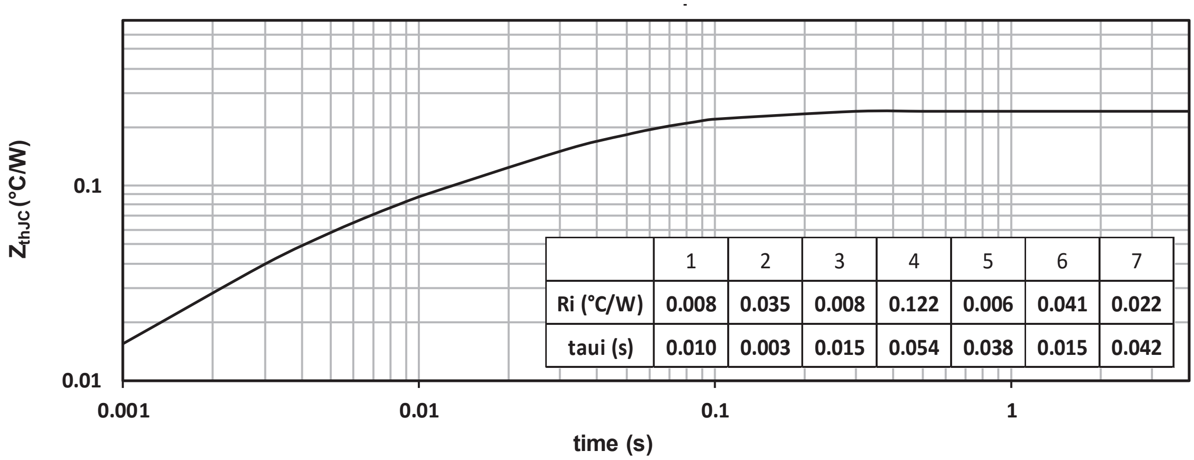
Figure 1-10. Reverse Bias Safe Operating Area



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



	1	2	3	4	5	6	7
Ri (°C/W)	0.008	0.035	0.008	0.122	0.006	0.041	0.022
taui (s)	0.010	0.003	0.015	0.054	0.038	0.015	0.042

Figure 1-12. Forward Characteristics

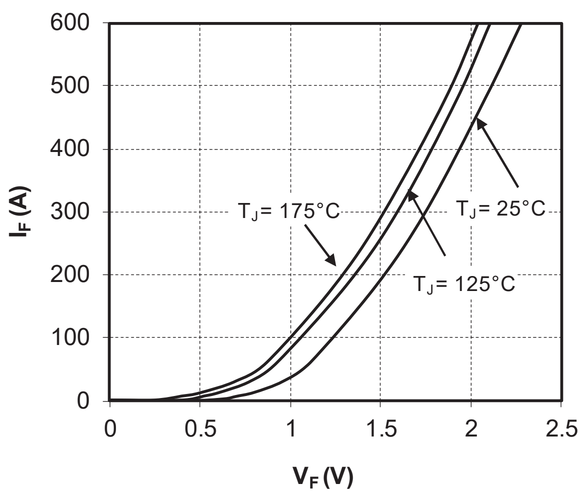


Figure 1-13. Switching Losses vs. Gate Resistance

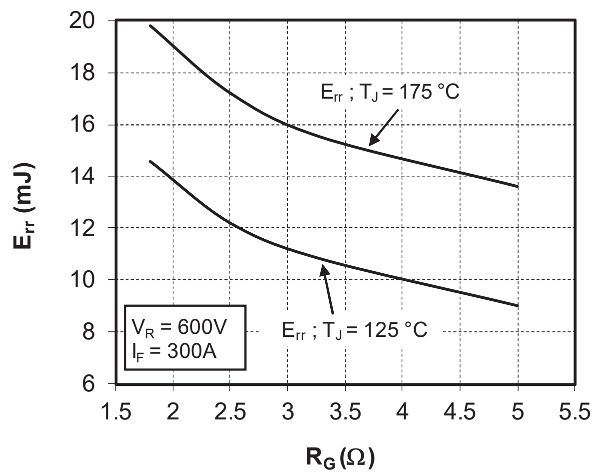
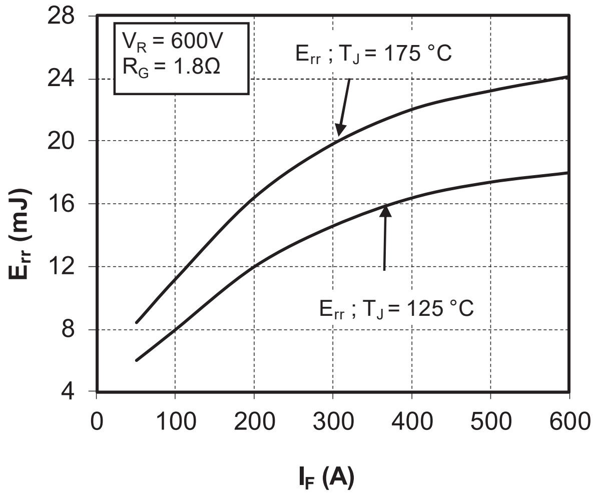


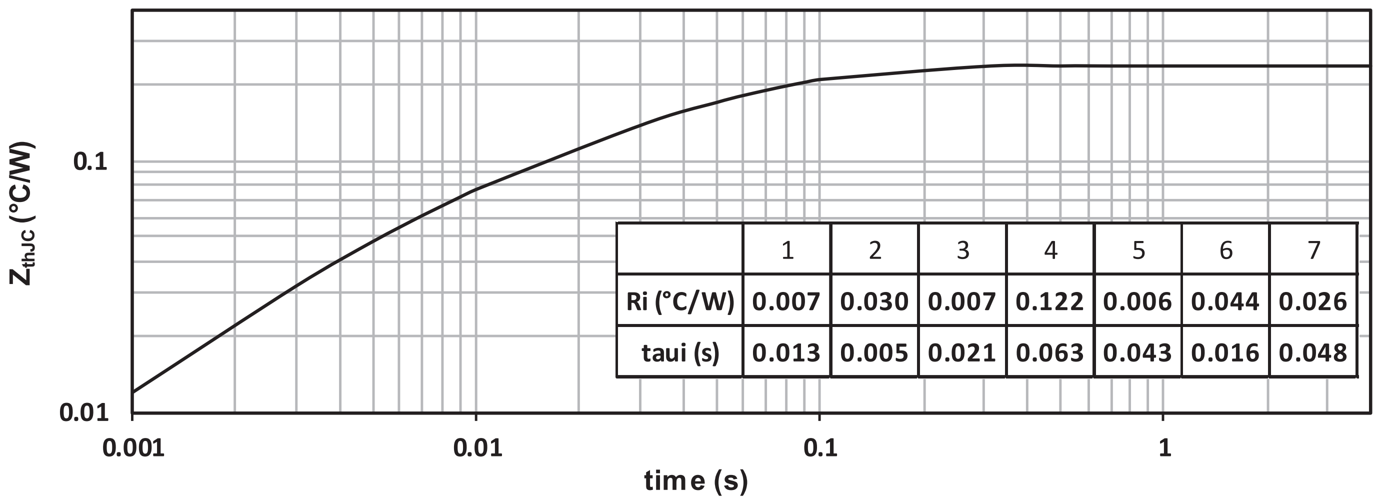
Figure 1-14. Switching Losses vs. Forward Current



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



	1	2	3	4	5	6	7
Ri (°C/W)	0.007	0.030	0.007	0.122	0.006	0.044	0.026
taui (s)	0.013	0.005	0.021	0.063	0.043	0.016	0.048

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

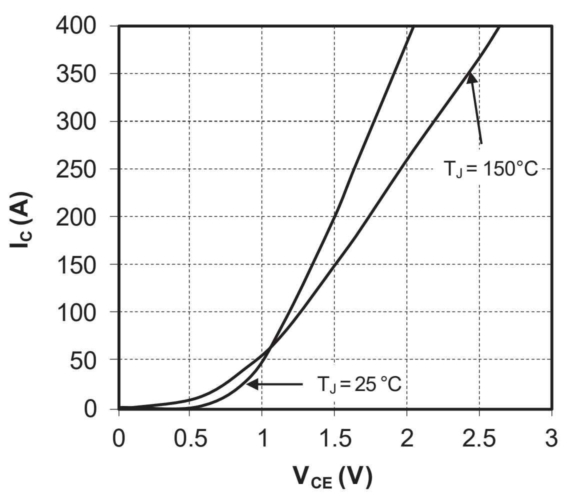


Figure 1-17. Output Characteristics, T_J = 175 °C

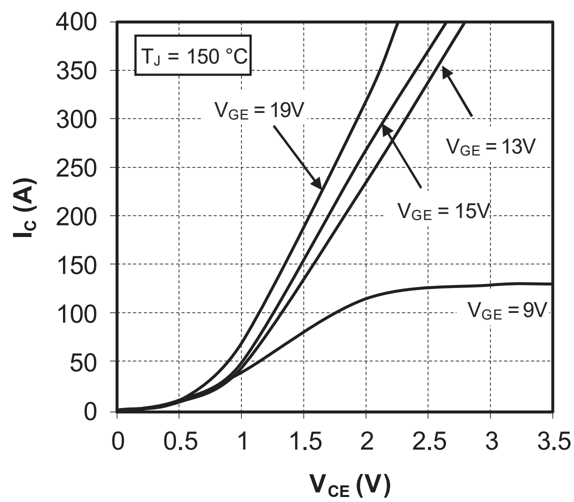


Figure 1-18. Switching Losses vs. Gate Resistance

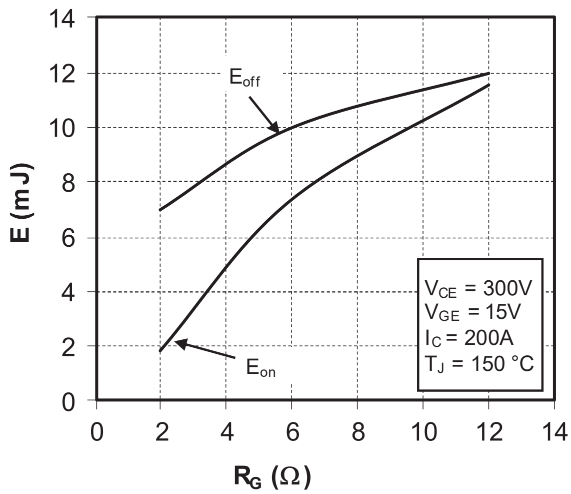


Figure 1-19. Switching Losses vs. Collector Current

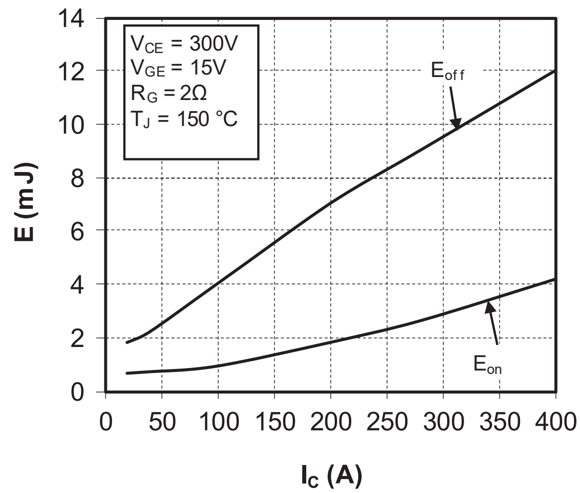


Figure 1-20. Operating Frequency vs. Collector Current

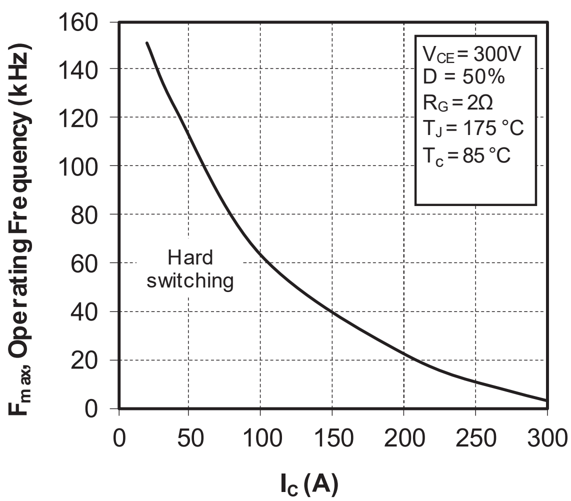


Figure 1-21. Reverse Bias Safe Operating Area

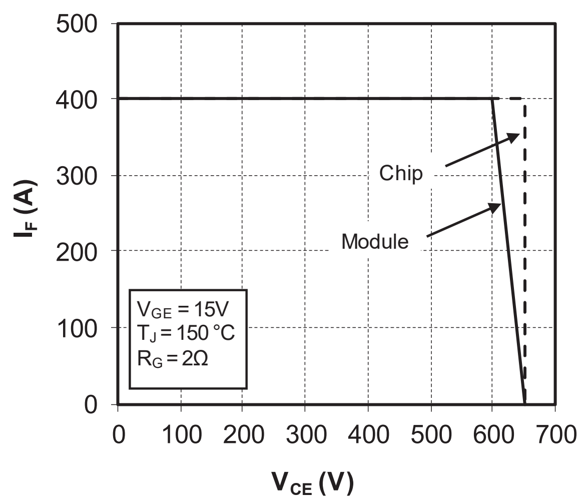
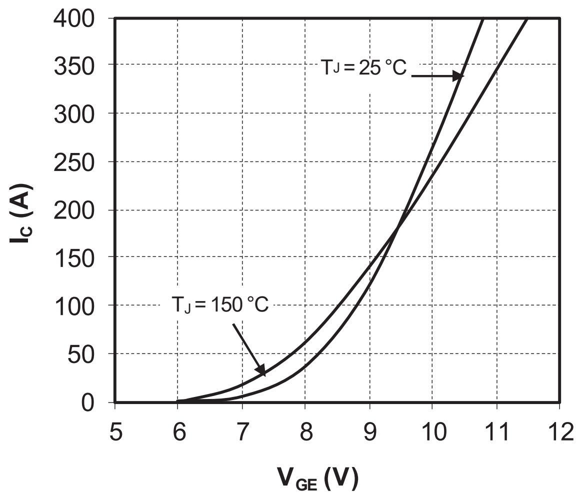


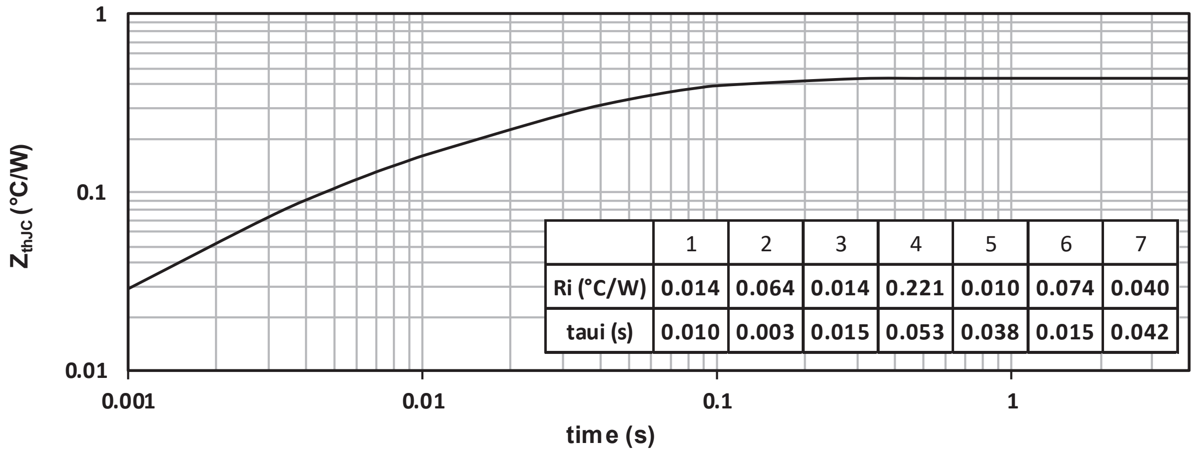
Figure 1-22. Transfer Characteristics



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



	1	2	3	4	5	6	7
Ri (°C/W)	0.014	0.064	0.014	0.221	0.010	0.074	0.040
taui (s)	0.010	0.003	0.015	0.053	0.038	0.015	0.042

Figure 1-24. Forward Characteristics

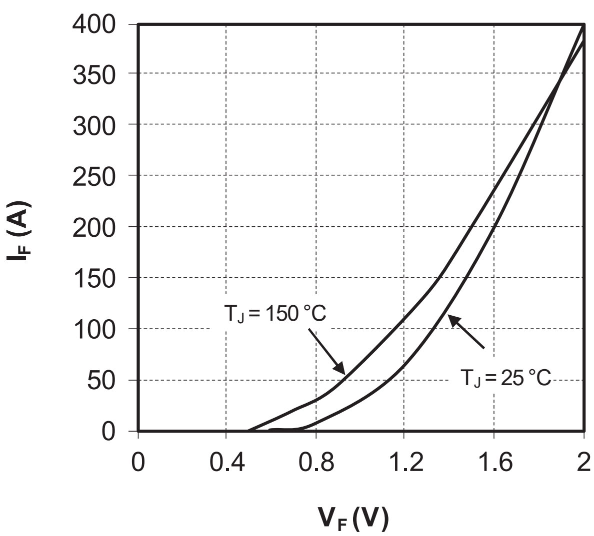


Figure 1-25. Switching Losses vs. Gate Resistance

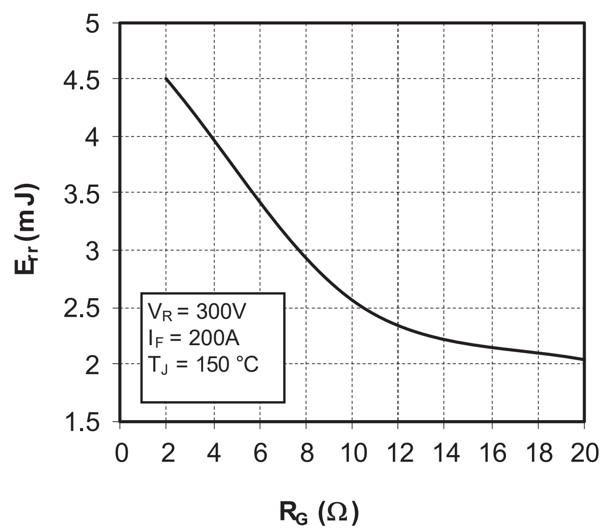
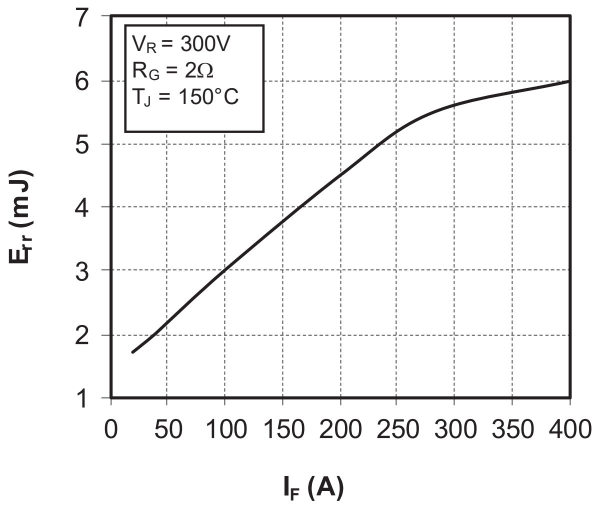


Figure 1-26. Switching Losses vs. Forward Current



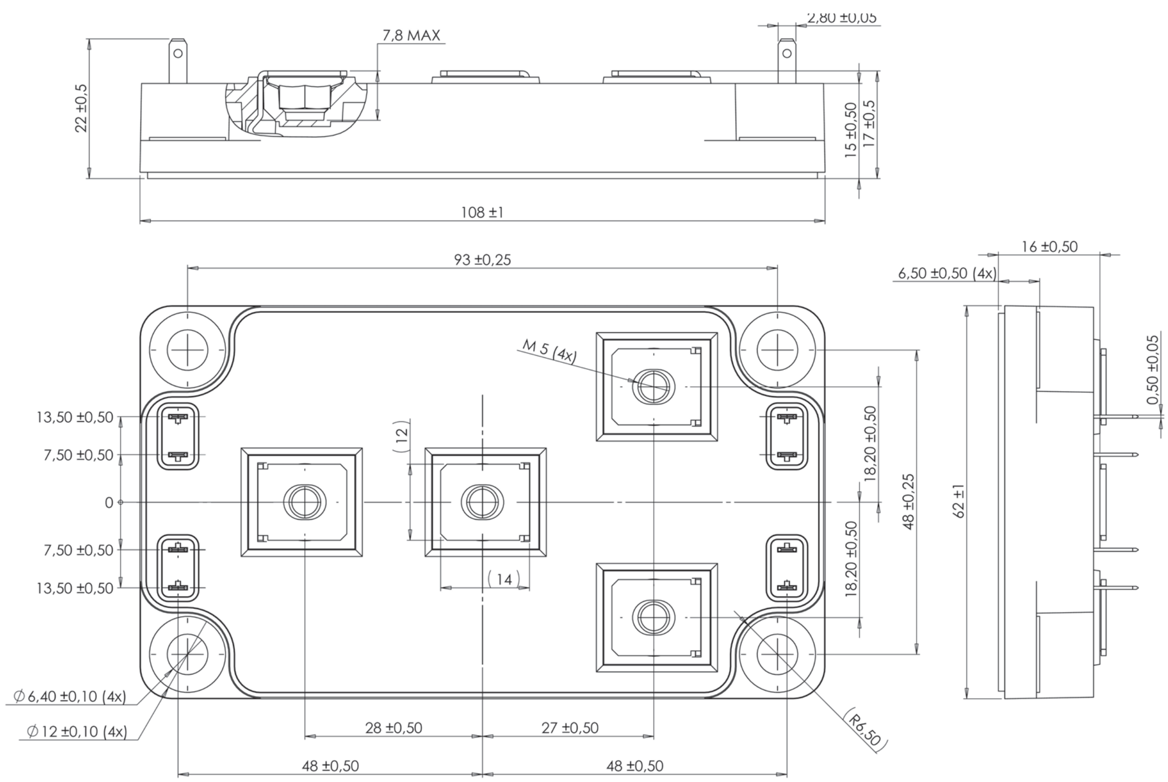
2. Package Specifications

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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- Technical Support

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