

Phase Leg IGBT 7 Power Module APTX600A170T6G



Product Overview

The APTGX600A170T6G device is a phase leg 1700V, 600A Insulated-Gate Bipolar Transistor (IGBT) 7 power module.

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

Figure 1. Electrical Diagram

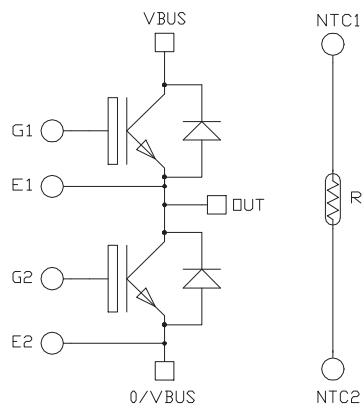
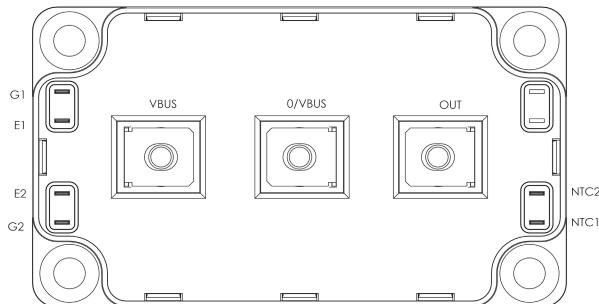


Figure 2. Pinout Location



Note:

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

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

Features

The APTGX600A170T6G device has the following key features:

- IGBT 7
 - Low-voltage drop
 - Low-leakage current
- Very low-stray inductance
- Kelvin emitter for easy drive
- M5 power connectors
- Internal thermistor for temperature monitoring
- Al_2O_3 substrate and copper base plate

Benefits

The APTGX600A170T6G 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 APTGX600A170T6G device has the following potential 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 APTX600A170T6G device.

1.1 IGBT Characteristics (Per IGBT)

The following table lists the absolute maximum ratings (per IGBT) of the APTX600A170T6G device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Maximum Ratings	Unit
V_{CES}	Collector-emitter voltage	1700	V
I_C	Continuous collector current	$T_C = 25^\circ\text{C}$	750
		$T_C = 65^\circ\text{C}$	600
I_{CM}	Pulsed collector current, t_p limited by $T_{J(\text{max})}$	1200	
V_{GE}	Gate-emitter voltage	± 20	V
P_D	Power dissipation	$T_C = 25^\circ\text{C}$	1948

The following table lists the electrical characteristics (per IGBT) of the APTX600A170T6G device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{CES}	Zero gate voltage collector current	$V_{GE} = 0\text{V}$; $V_{CE} = 1700\text{V}$	—	—	50	μA
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{V}$	$T_J = 25^\circ\text{C}$	—	1.7	2
		$I_C = 600\text{A}$	$T_J = 125^\circ\text{C}$	—	1.95	—
			$T_J = 175^\circ\text{C}$	—	2.1	—
$V_{GE(\text{th})}$	Gate threshold voltage	$V_{GE} = V_{CE}$; $I_C = 12.6\text{ mA}$	5.15	5.8	6.45	
I_{GES}	Gate-emitter leakage current	$V_{GE} = 20\text{V}$; $V_{CE} = 0\text{V}$	—	—	200	nA

The following table lists the dynamic characteristics (per IGBT) of the APTGX600A170T6G device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{GE} = 0V$ $V_{CE} = 25V$ $f = 100$ kHz	—	62.5	—	nF
C_{oes}	Output capacitance		—	1	—	
C_{res}	Reverse transfer capacitance		—	0.22	—	
Q_G	Gate charge	$V_{GE} = \pm 15V$ $V_{CE} = 900V$ $I_C = 600A$	—	5.6	—	μC
$T_{d(on)}$	Turn-on delay time		$T_J = 25$ °C	172	—	ns
			$T_J = 125$ °C	186	—	
			$T_J = 175$ °C	192	—	
			$T_J = 25$ °C	41	—	
T_r	Rise time	$V_{GE} = \pm 15V$ $V_{Bus} = 900V$ $I_C = 600A$	$T_J = 125$ °C	67	—	
			$T_J = 175$ °C	73	—	
$T_{d(off)}$	Turn-off delay time	$R_G = 1.1\Omega$	$T_J = 25$ °C	441	—	
			$T_J = 125$ °C	538	—	
			$T_J = 175$ °C	583	—	
			$T_J = 25$ °C	270	—	
T_f	Fall time		$T_J = 125$ °C	429	—	
			$T_J = 175$ °C	556	—	
E_{on}	Turn-on energy	$V_{GE} = \pm 15V$ $V_{Bus} = 900V$ $I_C = 600A$	$T_J = 25$ °C	70.8	—	mJ
			$T_J = 125$ °C	110	—	
			$T_J = 175$ °C	136.4	—	
E_{off}	Turn-off energy	$R_G = 1.1\Omega$ $di/dt = 12.8$ kA/μs $dv/dt = 6.1$ kV/μs	$T_J = 25$ °C	94.4	—	
			$T_J = 125$ °C	133.6	—	
			$T_J = 175$ °C	160.8	—	
R_{Gint}	Internal gate resistance		—	0.33	—	Ω
I_{sc}	Short circuit data	$V_{GE} \leq 15V$ $V_{Bus} = 1000V$ $t_p \leq 8$ μs	$T_J = 150$ °C	2100	—	A
		$V_{GE} \leq 15V$ $V_{Bus} = 1000V$ $t_p \leq 7$ μs	$T_J = 175$ °C	2000	—	
R_{thJC}	Junction-to-case thermal resistance		—	—	0.077	°C/W

1.2 Diode Characteristics (Per Diode)

The following table lists the diode characteristics (per diode) of the APTGX600A170T6G device.

Table 1-4. Diode Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
V_{RRM}	Peak repetitive reverse voltage			—	—	1700	V
I_{RM}	Reverse leakage current	$V_R = 1700V$		—	—	50	μA
I_{FRM}	Repetitive forward current, t_p limited by $T_{J(max)}$			—	1200	—	A
I^2t	I^2t value	$t_p = 10$ ms	$T_J = 125$ °C	—	17800	—	A^2s
		$V_R = 0V$	$T_J = 175$ °C	—	15300	—	
I_F	DC forward current			—	600	—	A
V_F	Diode forward voltage	$I_F = 600A$ $V_{GE} = 0V$	$T_J = 25$ °C $T_J = 125$ °C $T_J = 175$ °C	— — —	2.35 2.25 2.1	2.7	V
I_{RRM}	Reverse recovery current	$V_{GE} = -15V$ $I_F = 600A$ $V_R = 900V$ $di/dt = 12.8$ kA/ μs	$T_J = 25$ °C $T_J = 125$ °C $T_J = 175$ °C	— — —	640 740 782	—	A
Q_{rr}	Reverse recovery charge		$T_J = 25$ °C $T_J = 125$ °C $T_J = 175$ °C	— — —	62 140 174	—	μC
E_{rr}	Reverse recovery energy		$T_J = 25$ °C $T_J = 125$ °C $T_J = 175$ °C	— — —	38 79.4 116.6	—	mJ
R_{thJC}	Junction-to-case thermal resistance				—	0.14	°C/W

1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the APTGX600A170T6G device.

Table 1-5. 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
L_{stray}	Stray inductance module	—	15	—	nH
d_{creep}	Creepage distance terminal-to-terminal	—	14.5	—	mm
	Creepage distance terminal-to-heatsink	—	15.9	—	
d_{clear}	Clearance distance terminal-to-terminal	—	11.4	—	mm
	Clearance distance terminal-to-heatsink	—	12.1	—	
R_{CE}	Lead resistance terminal-to-chip	$T_C = 25$ °C, per switch		0.5	—
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	—
		For terminals	M5	2	—
Wt	Package weight	—	282	—	g

The following table lists the temperature sensor NTC of the APTGX600A170T6G device.

Table 1-6. Temperature Sensor NTC

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

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]} \quad \begin{array}{l} T: \text{Thermistor temperature} \\ R_T: \text{Thermistor value at } T \end{array}$$

Note: For more information, see [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#).

1.4 Typical IGBT Performance Curve

The following figures show the IGBT performance curves of the APTGX600A170T6G device.

Figure 1-1. Maximum Thermal Impedance

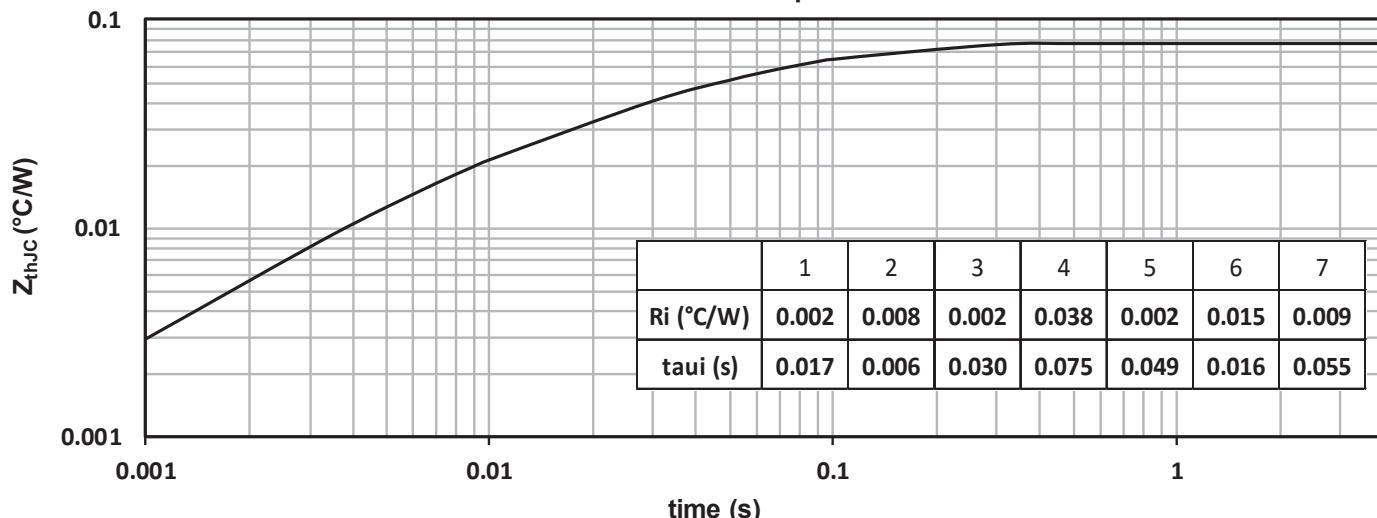


Figure 1-2. Output Characteristics, $V_{GE} = 15V$

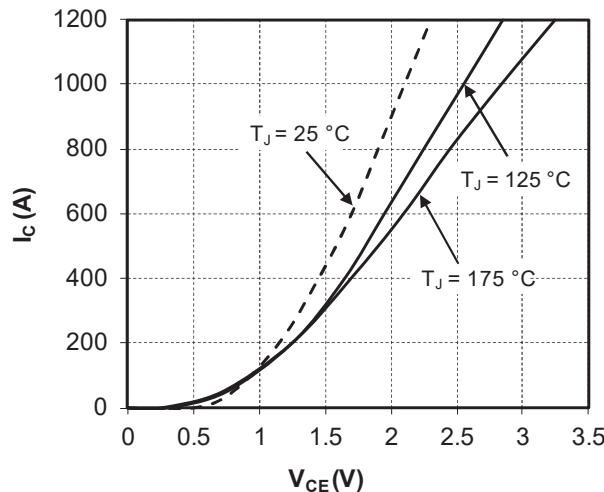


Figure 1-3. Output Characteristics, $T_j = 175$ °C

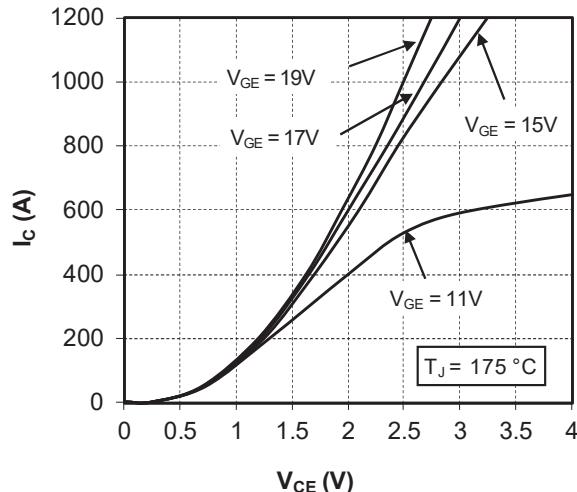


Figure 1-4. Switching Losses vs. Gate Resistance

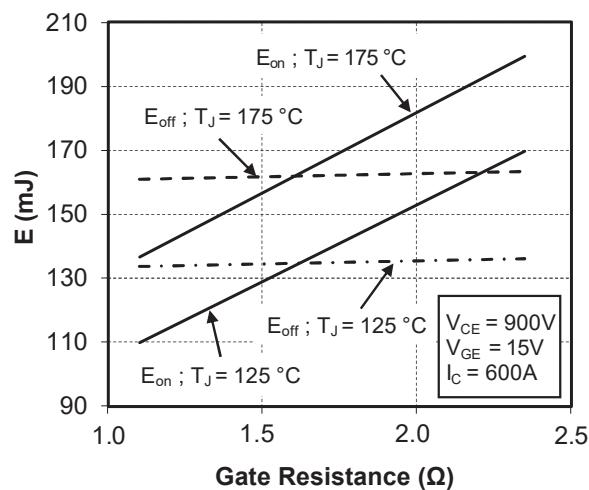


Figure 1-5. Switching Losses vs. Collector Current

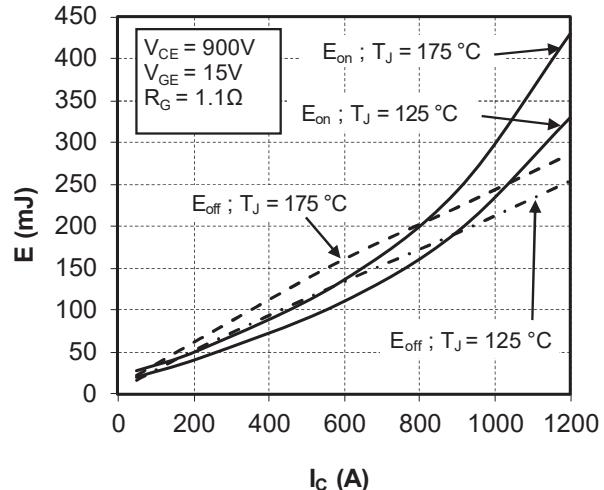


Figure 1-6. Operating Frequency vs. Collector Current

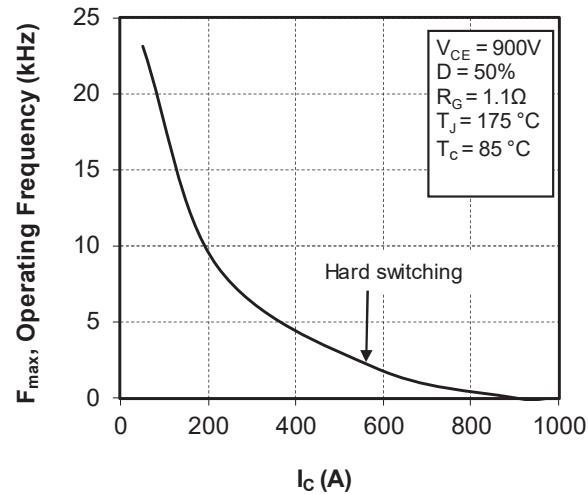


Figure 1-7. Gate Charge Characteristics

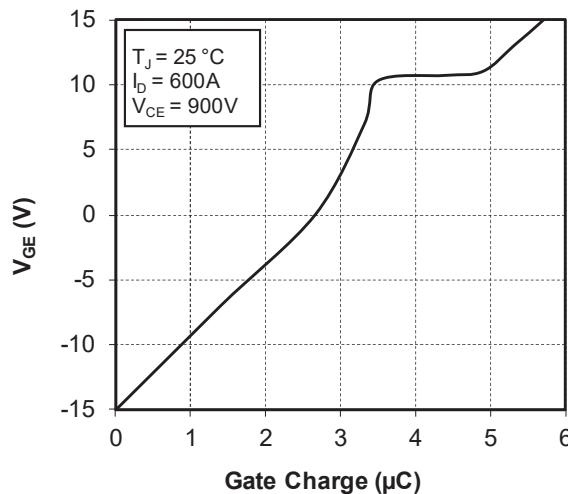


Figure 1-8. Transfer Characteristics

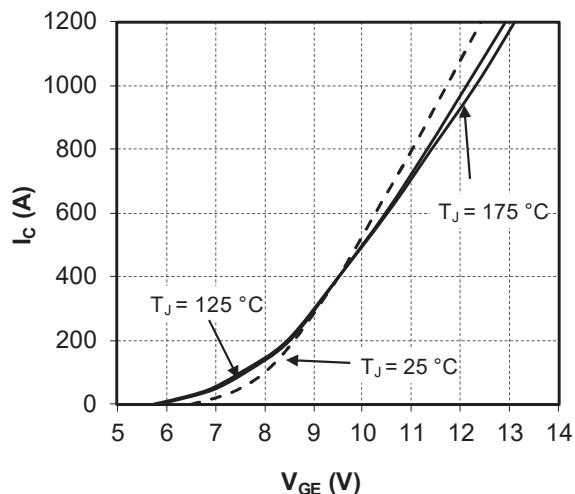


Figure 1-9. Capacity Characteristics

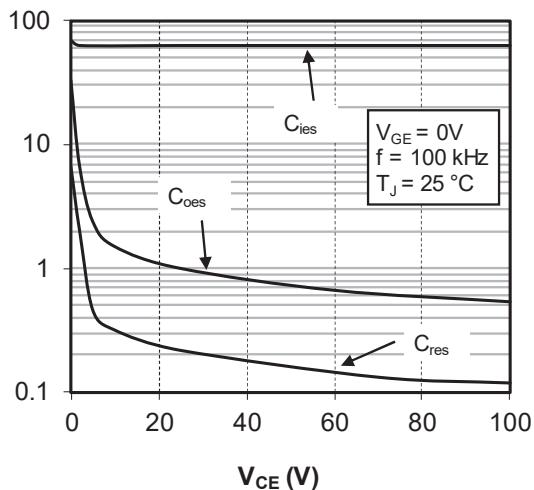
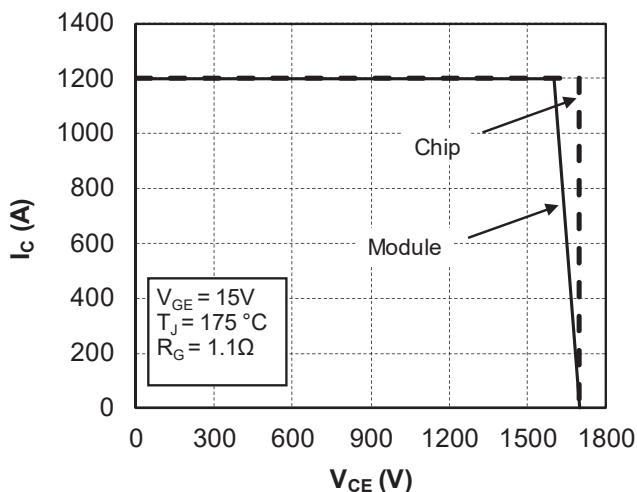


Figure 1-10. Reverse Bias Safe Operating Area



1.5 Typical Diode Performance Curve

The following figures show the diode performance curves of the APTX600A170T6G device.

Figure 1-11. Maximum Thermal Impedance

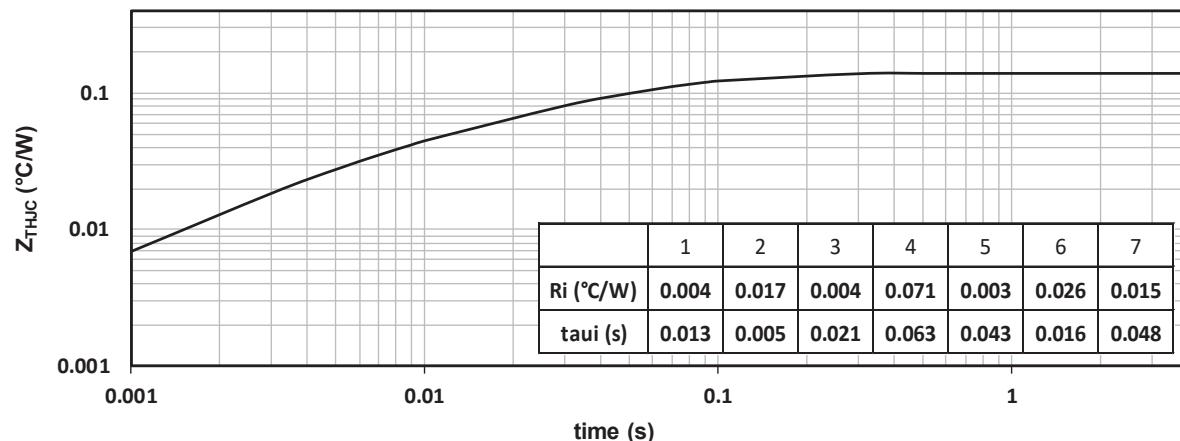


Figure 1-12. Forward Characteristics

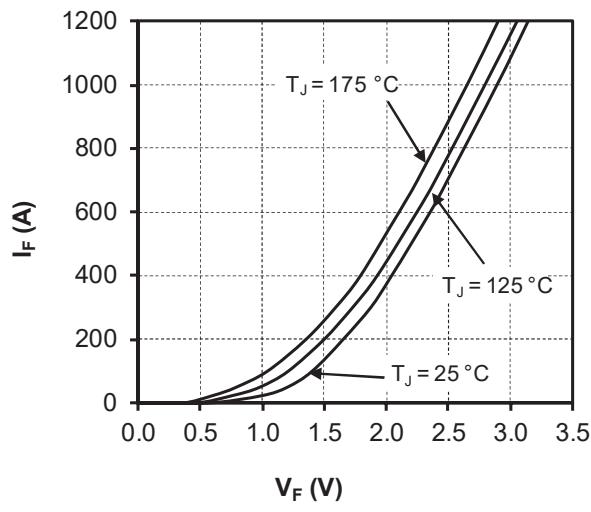


Figure 1-13. Switching Losses vs. Gate Resistance

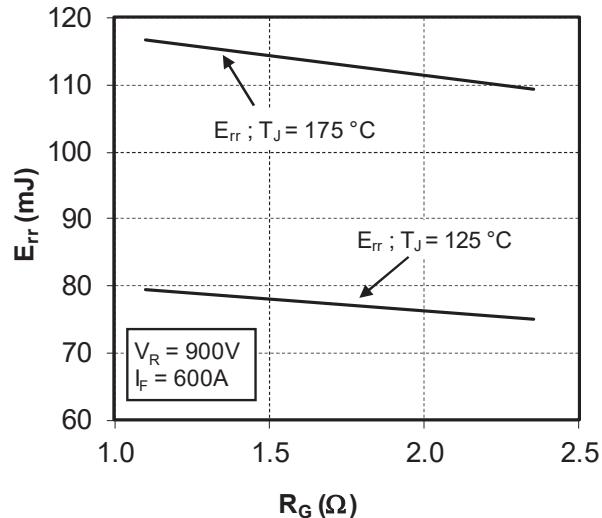
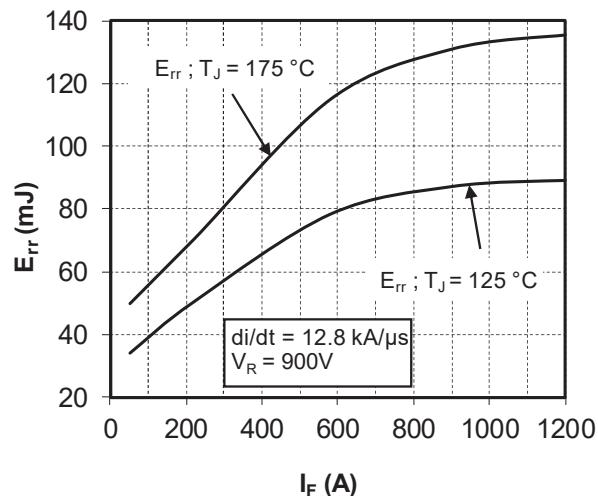


Figure 1-14. Switching Losses vs. Forward Current



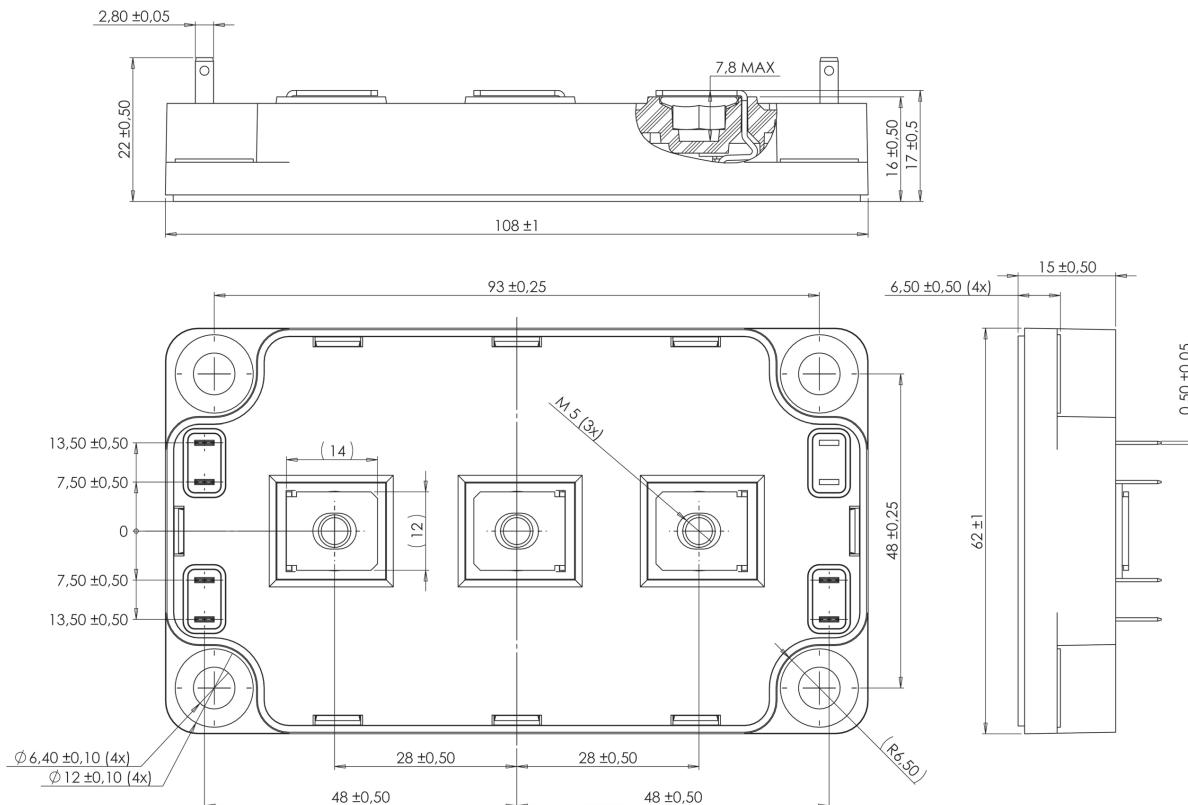
2. Package Specifications

The following section shows the package specification of the APTX600A170T6G device.

2.1 Package Outline

The following figure shows the package outline drawing of the APTX600A170T6G 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	11/2024	Initial revision

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: 979-8-3371-0065-4

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.