

1200 V, 50 A Fast Field-Stop IGBT 7 with DQ Diode
APT50GH120BD30



Product Overview

1200 V, 50 A Fast Field-Stop IGBT with co-packaged, anti-parallel DQ diode, TO-247

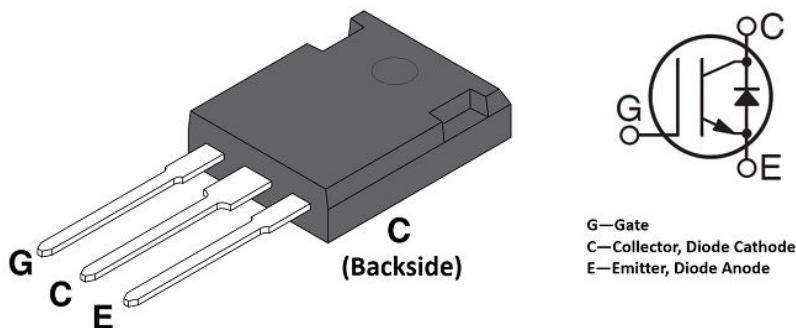


Table 1. Ordering Information

Catalog Part Number (CPN)	Package	Packing Media	Qualification
APT50GH120BD30	TO-247	Tube	Industrial

Features

- Low conduction loss and saturation voltage
- Fast switching
- Low gate charge
- Ultrafast tail current shutoff
- Soft recovery
- Reverse-bias safe operating area (RBSOA) rated
- Easy to parallel
- RoHS compliant

1. Device Specifications: IGBT

This section shows the specifications of this device.

1.1. Absolute Maximum Ratings

The following table shows the absolute maximum ratings of this device. $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{CES}	Collector-emitter voltage	1200	V
V_{GE}	Gate-emitter voltage	± 20	
I_{C1}	Continuous collector current ¹ ($T_C = 25\text{ }^{\circ}\text{C}$)	119	A
I_{C2}	Continuous collector current ¹ ($T_C = 100\text{ }^{\circ}\text{C}$)	73	
I_{CM}	Pulsed collector current ² ($T_C = 175\text{ }^{\circ}\text{C}$)	200	
RBSOA	Reverse-bias safe operating area ($T_J = 150\text{ }^{\circ}\text{C}$, 960 V)	200	
P_D	Total power dissipation	492	W

Notes:

- Limited by maximum lead temperature.
- Repetitive rating: Pulse width and case temperature are limited by the maximum junction temperature.

1.2. Thermal and Mechanical Characteristics

The following table shows the thermal and mechanical characteristics of this device.

Table 1-2. Thermal and Mechanical Characteristics

Symbol	Characteristic	Min.	Typ.	Max.	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance (IGBT)		0.21	0.31	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Junction-to-case thermal resistance (diode)			0.8	
T_J, T_{STG}	Operating and storage junction temperature	-40		175	$^{\circ}\text{C}$
T_L	Lead temperature for 10 seconds			300	
τ_M	Mounting torque, M3 screw for heat sink attachment (requires 1, not included)		0.8		N·m
Wt	Package weight		6.2		g

1.3. Electrical Performance

The following table shows the static characteristics of this device. $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 1-3. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 0.8\text{ mA}$	4.7	5.5	6.2	V
$V_{CE(on)}$	Collector-emitter on voltage	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$		1.7	2.15	
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 175\text{ }^{\circ}\text{C}$		2.1		
I_{CES}	Collector cut-off current	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$			140	μA
		$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}, T_J = 175\text{ }^{\circ}\text{C}$		4000		
I_{GES}	Gate-emitter leakage current	$V_{GE} = \pm 20\text{ V}$			± 100	nA

The following table shows the dynamic characteristics of this device. $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{GE} = 0\text{ V}, V_{CE} = 25\text{ V}, f = 200\text{ kHz}$		6885		pF
C_{res}	Reverse transfer capacitance			36		
C_{oes}	Output capacitance			95		
V_{GEP}	Gate-to-emitter plateau voltage	$V_{GE} = 15\text{ V}, V_{CE} = 960\text{ V}, I_C = 50\text{ A}$		7.5		V
Q_G	Total gate charge ¹			375		nC
Q_{GE}	Gate-emitter charge			46		
Q_{GC}	Gate-collector ("Miller") charge			143		
RBSOA	Reverse-bias safe operating area	$T_J = 175\text{ }^{\circ}\text{C}, R_G = 23\text{ }\Omega, V_{GE} = 15\text{ V}, V_{CE} = 800\text{ V}, L = 100\text{ }\mu\text{H}$	200			A
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 800\text{ V}, V_{GE} = 15\text{ V}, I_C = 50\text{ A}, R_G = 5\text{ }\Omega, T_J = 25\text{ }^{\circ}\text{C}$		22		ns
t_r	Current rise time			31		
$t_{d(off)}$	Turn-off delay time			222		
t_f	Current fall time			25		
E_{on1}	Turn-on switching energy ²	$V_{CC} = 800\text{ V}, V_{GE} = 15\text{ V}, I_C = 50\text{ A}, R_G = 5\text{ }\Omega, T_J = 125\text{ }^{\circ}\text{C}$		2220		μJ
E_{on2}	Turn-on energy with diode ³			2830		
E_{off}	Turn-off switching energy ⁴			1470		
$t_{d(on)}$	Turn-on delay time			22		ns
t_r	Current rise time			31		
$t_{d(off)}$	Turn-off delay time			259		
t_f	Current fall time			40		
E_{on1}	Turn-on switching energy ²			2300		μJ
E_{on2}	Turn-on energy with diode ³			4240		
E_{off}	Turn-off switching energy ⁴			2440		

Notes:

1. See MIL-STD-750 Method 3471.
2. E_{on1} is the clamped inductive turn-on-energy of the IGBT only, without the effect of a commutating diode reverse recovery current adding to the IGBT turn-on loss. (See [Figure 1-19](#), [Figure 1-20](#).)
3. E_{on2} is the clamped inductive turn-on energy that includes a commutating diode reverse recovery current in the IGBT turn-on switching loss. (See [Figure 1-19](#), [Figure 1-20](#).)
4. E_{off} is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1. (See [Figure 1-19](#), [Figure 1-21](#).)

1.4. Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

Figure 1-1. Output Characteristics

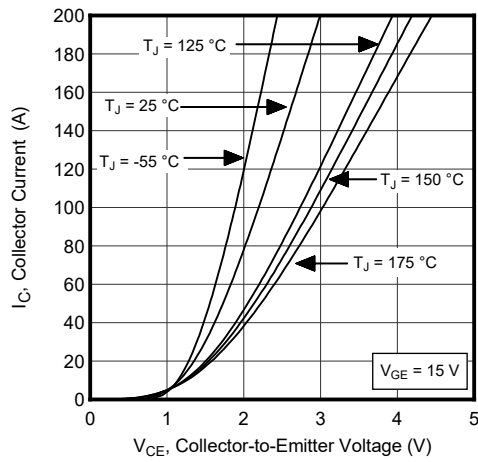


Figure 1-2. Transfer Characteristics

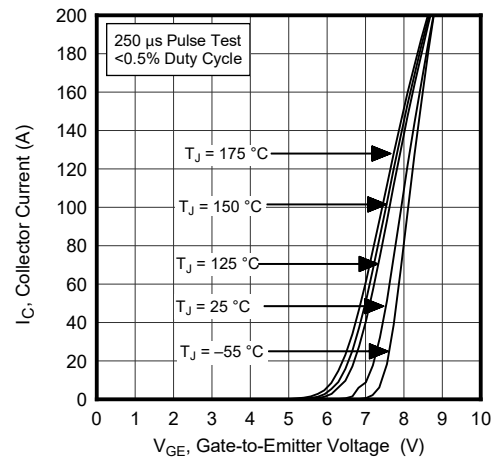


Figure 1-3. Gate Charge

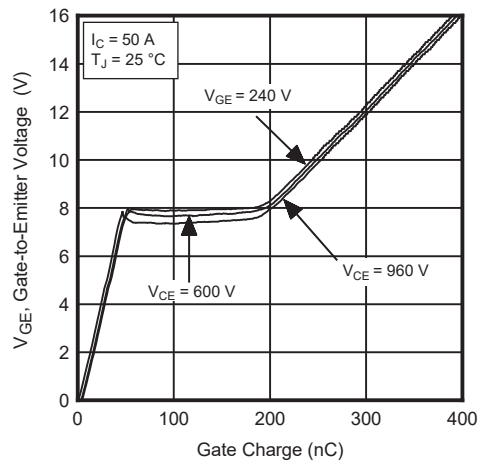


Figure 1-4. On-State Voltage vs. Gate-to-Emitter Voltage

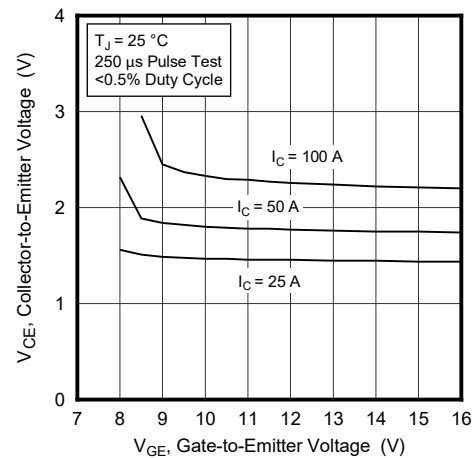


Figure 1-5. On-State Voltage vs. Junction Temperature

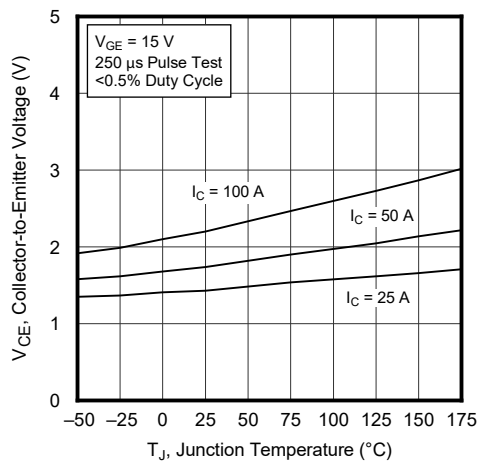


Figure 1-6. DC Collector Current vs. Case Temperature

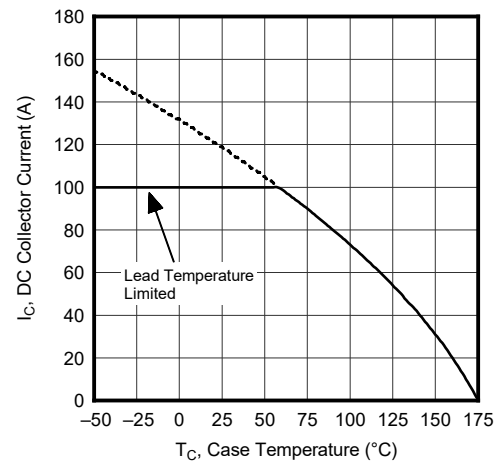


Figure 1-7. Turn-On Delay Time vs. Collector Current

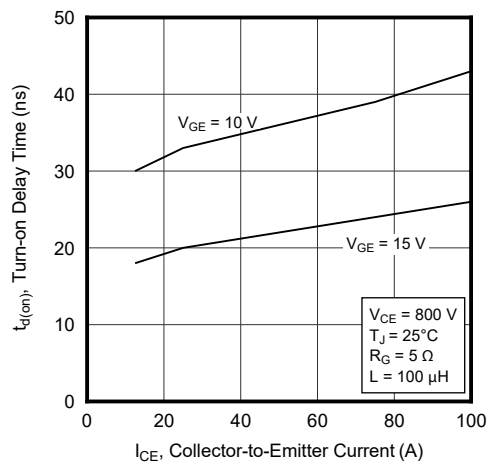


Figure 1-8. Turn-Off Delay Time vs. Collector Current

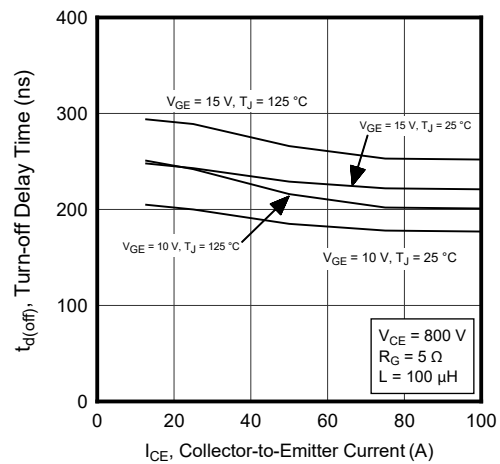


Figure 1-9. Current Rise Time vs. Collector Current

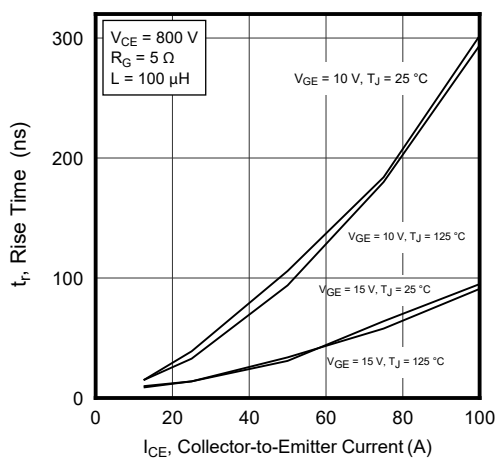


Figure 1-10. Current Fall Time vs. Collector Current

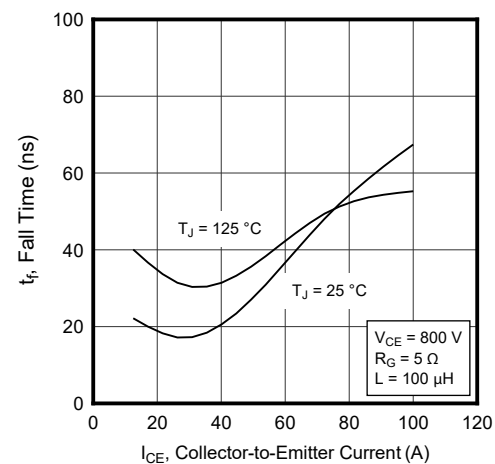


Figure 1-11. Turn-On Energy Loss vs. Collector Current

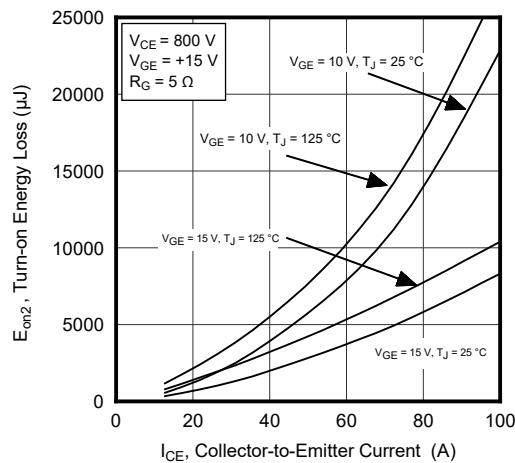


Figure 1-12. Turn-Off Energy Loss vs. Collector Current

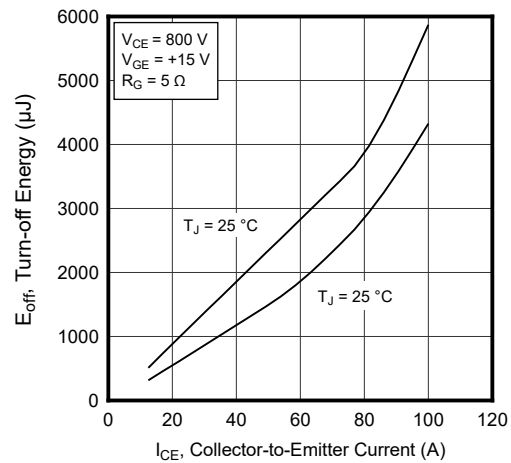


Figure 1-13. Switching Energy Losses vs. Gate Resistance

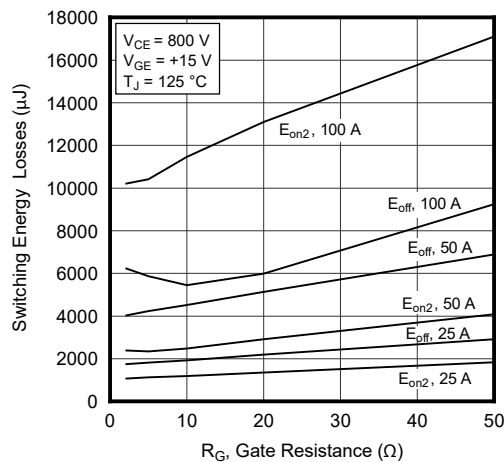


Figure 1-14. Switching Energy Losses vs. Junction Temperature

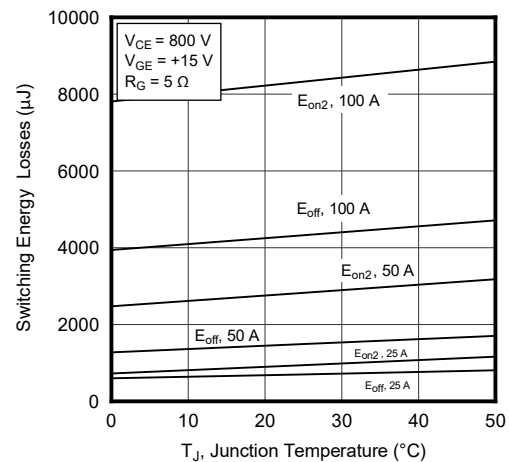


Figure 1-15. Capacitance vs. Collector-To-Emitter Voltage

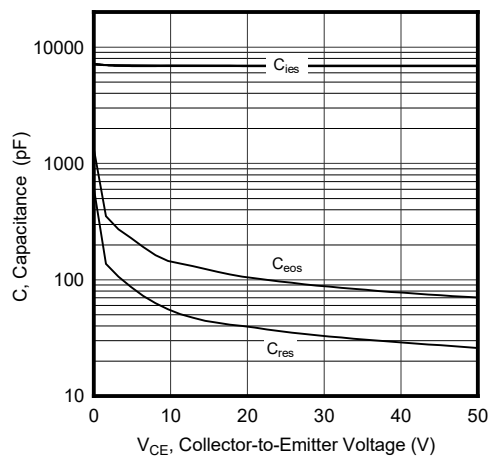


Figure 1-16. Reverse-bias Safe Operating Area

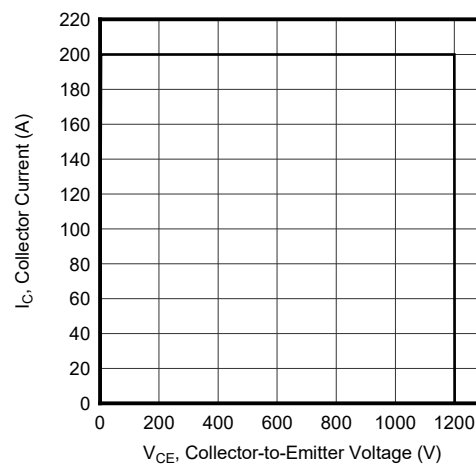


Figure 1-17. Maximum Transient Thermal Impedance

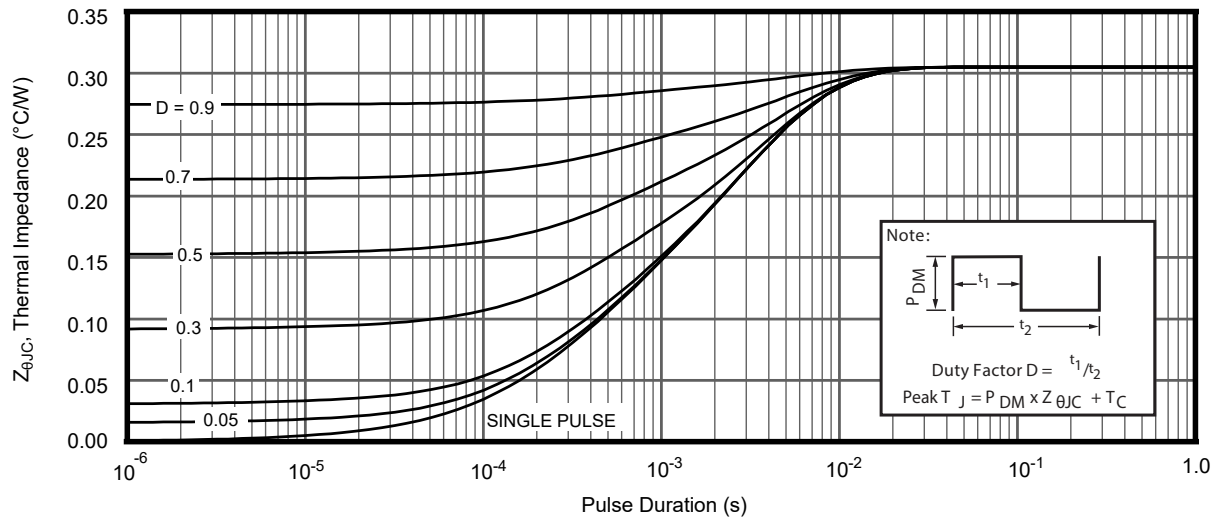


Figure 1-18. Transient Thermal Impedance Model

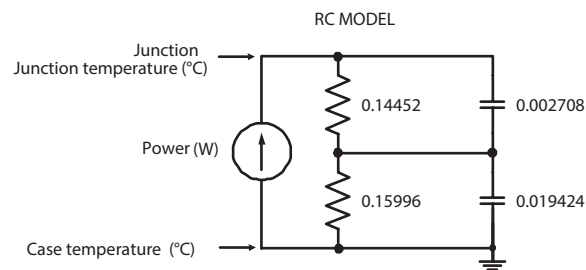


Figure 1-19. Inductive Switching Test Circuit

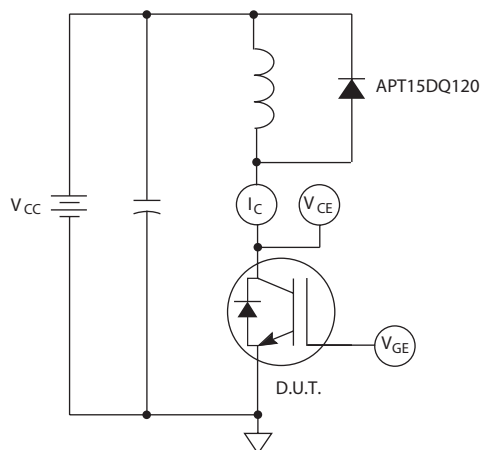


Figure 1-20. Turn-on Switching Waveform and Definitions

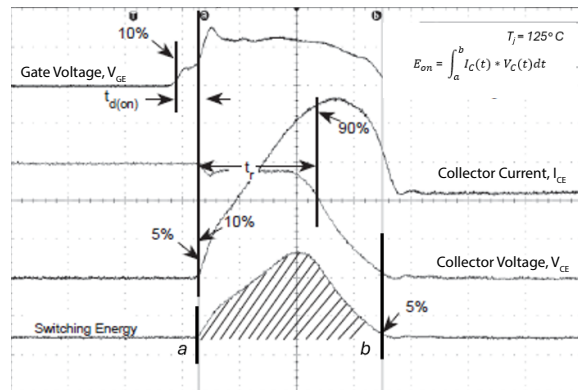
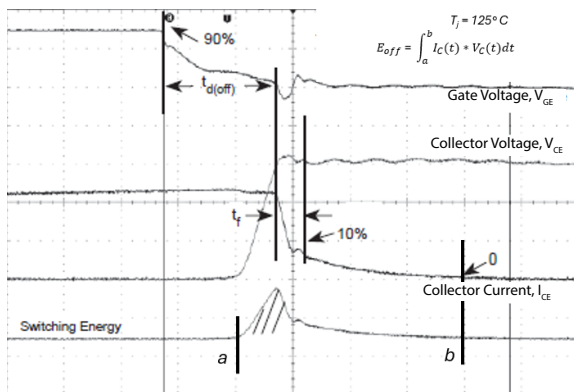


Figure 1-21. Turn-off Switching Waveform and Definitions



2. Device Specifications: Ultrafast Soft Recovery Anti-Parallel Diode

This section shows the specifications of the co-packaged, anti-parallel diode.

2.1. Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the anti-parallel diode. $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 2-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
$I_F(\text{AV})$	Maximum average forward current ($T_C = 117\text{ }^{\circ}\text{C}$, Duty Cycle = 0.5)	30	A
$I_F(\text{RMS})$	RMS forward current (square wave, 50% duty)	43	
I_{FSM}	Non-repetitive forward surge current ($T_J = 45\text{ }^{\circ}\text{C}$, 8.3 ms)	210	

2.2. Electrical Performance

The following table shows the static characteristics of the anti-parallel diode.

Table 2-2. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	$I_F = 30\text{ A}$, $T_J = 25\text{ }^{\circ}\text{C}$		2.8	3.3	V
		$I_F = 60\text{ A}$, $T_J = 25\text{ }^{\circ}\text{C}$		3.4		
		$I_F = 30\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$		2.1		

The following table shows the dynamic characteristics of the anti-parallel diode. $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 2-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	$I_F = 1\text{ A}$, $di_F/dt = -100\text{ A}/\mu\text{s}$, $V_R = 30\text{ V}$		26		ns
t_{rr}	Reverse recovery time	$I_F = 30\text{ A}$, $di_F/dt = -200\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$		320		
Q_{rr}	Reverse recovery charge			545		nC
I_{RRM}	Maximum reverse recovery current			4		A
t_{rr}	Reverse recovery time	$I_F = 30\text{ A}$, $di_F/dt = -200\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$		455		ns
Q_{rr}	Reverse recovery charge			2100		nC
I_{RRM}	Maximum reverse recovery current			9		A
t_{rr}	Reverse recovery time	$I_F = 30\text{ A}$, $di_F/dt = -1000\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$		180		ns
Q_{rr}	Reverse recovery charge			2975		nC
I_{RRM}	Maximum reverse recovery current			28		A

2.3. Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

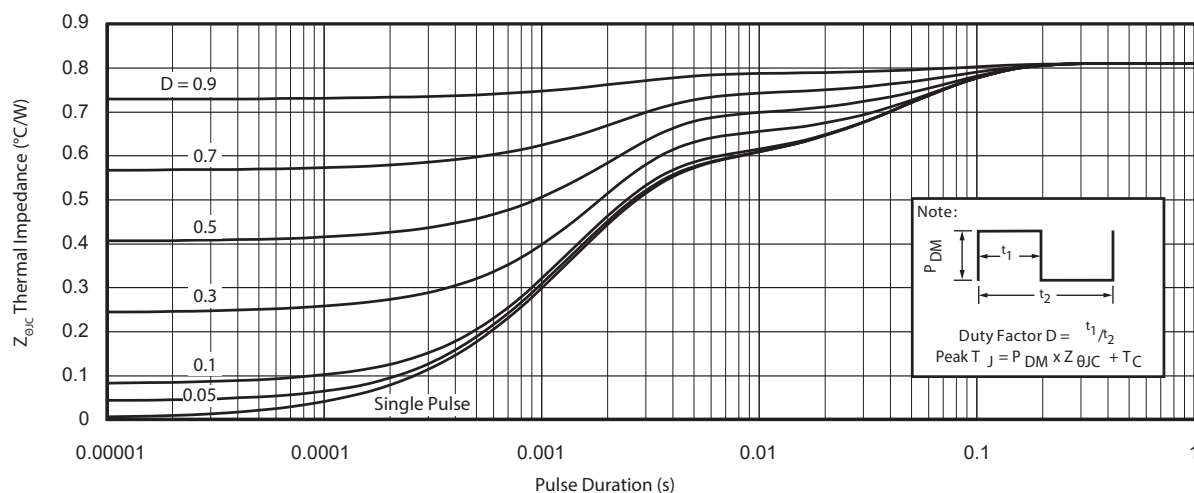
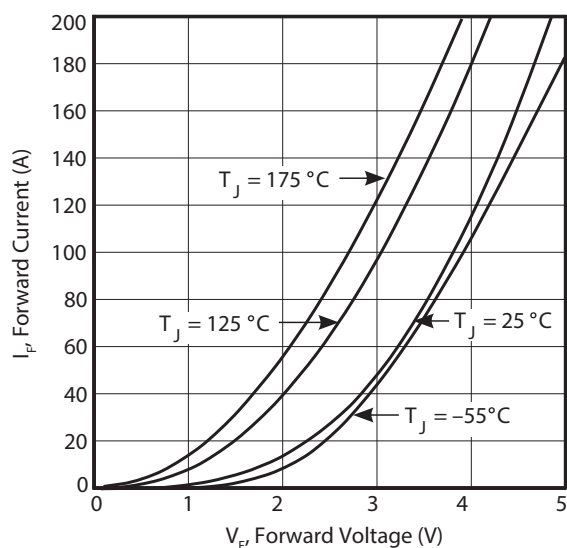
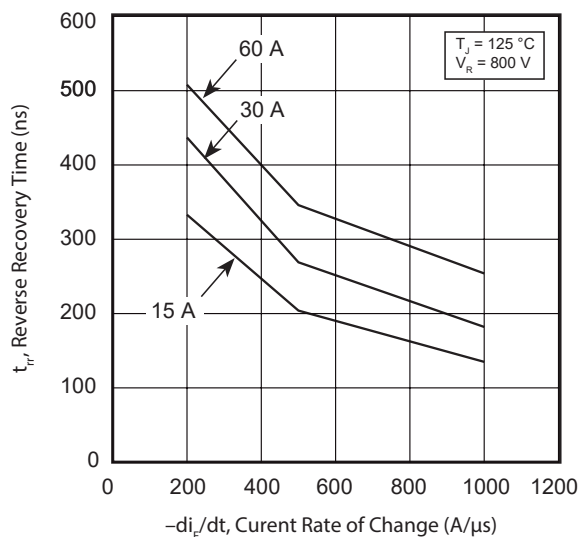
Figure 2-1. Maximum Transient Thermal Impedance**Figure 2-2.** Forward Current vs. Forward Voltage**Figure 2-3.** Reverse Recovery Time vs. Current Rate of Change

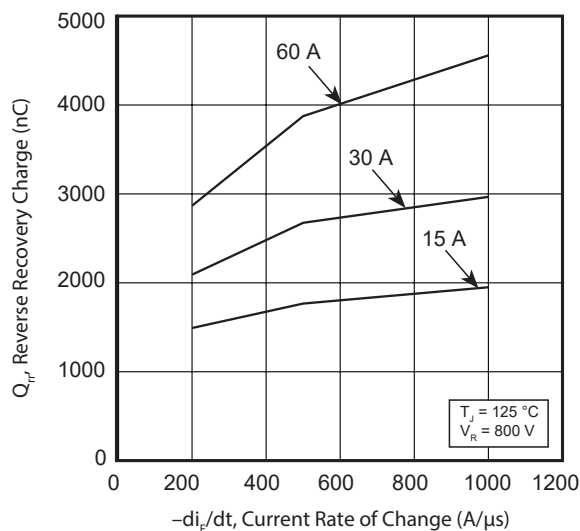
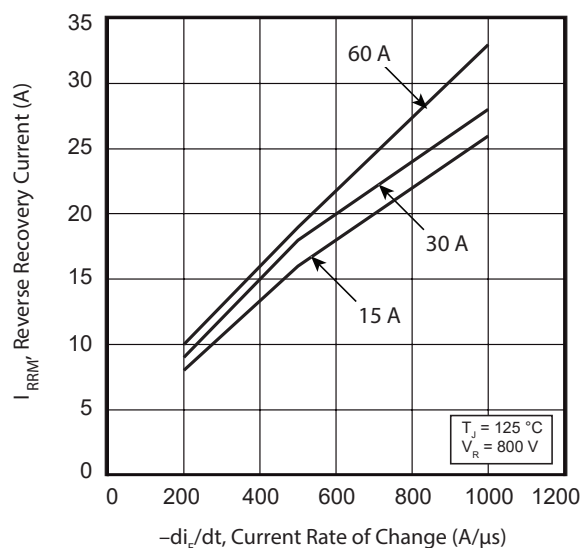
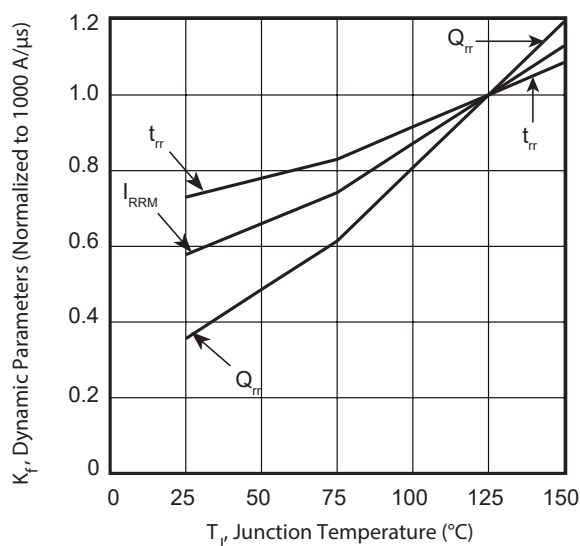
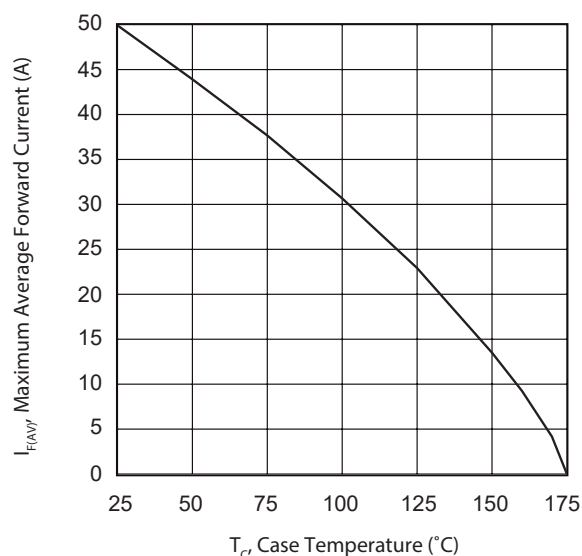
Figure 2-4. Reverse Recovery Charge vs. Current Rate of Change**Figure 2-5.** Reverse Recovery Current vs. Current Rate of Change**Figure 2-6.** Dynamic Parameters vs. Junction Temperature**Figure 2-7.** Maximum Average Forward Current vs. Case Temperature

Figure 2-8. Diode Test Circuit

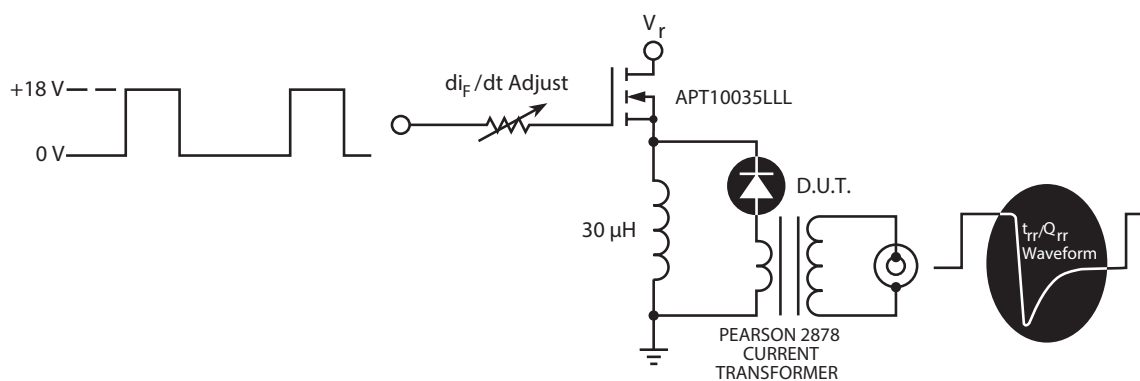
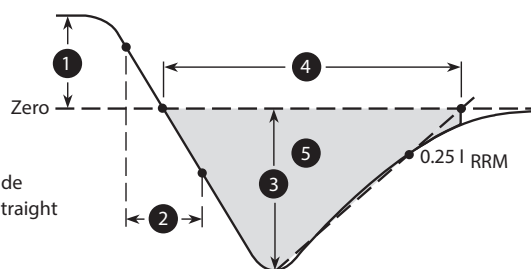


Figure 2-9. Diode Reverse Recovery Waveform and Definitions

- 1 I_F — Forward Conduction Current
- 2 di_F/dt — Rate of Diode Current Change Through Zero Crossing.
- 3 I_{RRM} — Maximum Reverse Recovery Current.
- 4 t_{rr} — Reverse Recovery Time, measured from zero crossing where diode current goes from positive to negative, to the point at which the straight line through I_{RRM} and $0.25 \cdot I_{RRM}$ passes through zero.
- 5 Q_{rr} — Area Under the Curve Defined by I_{RRM} and t_{rr} .



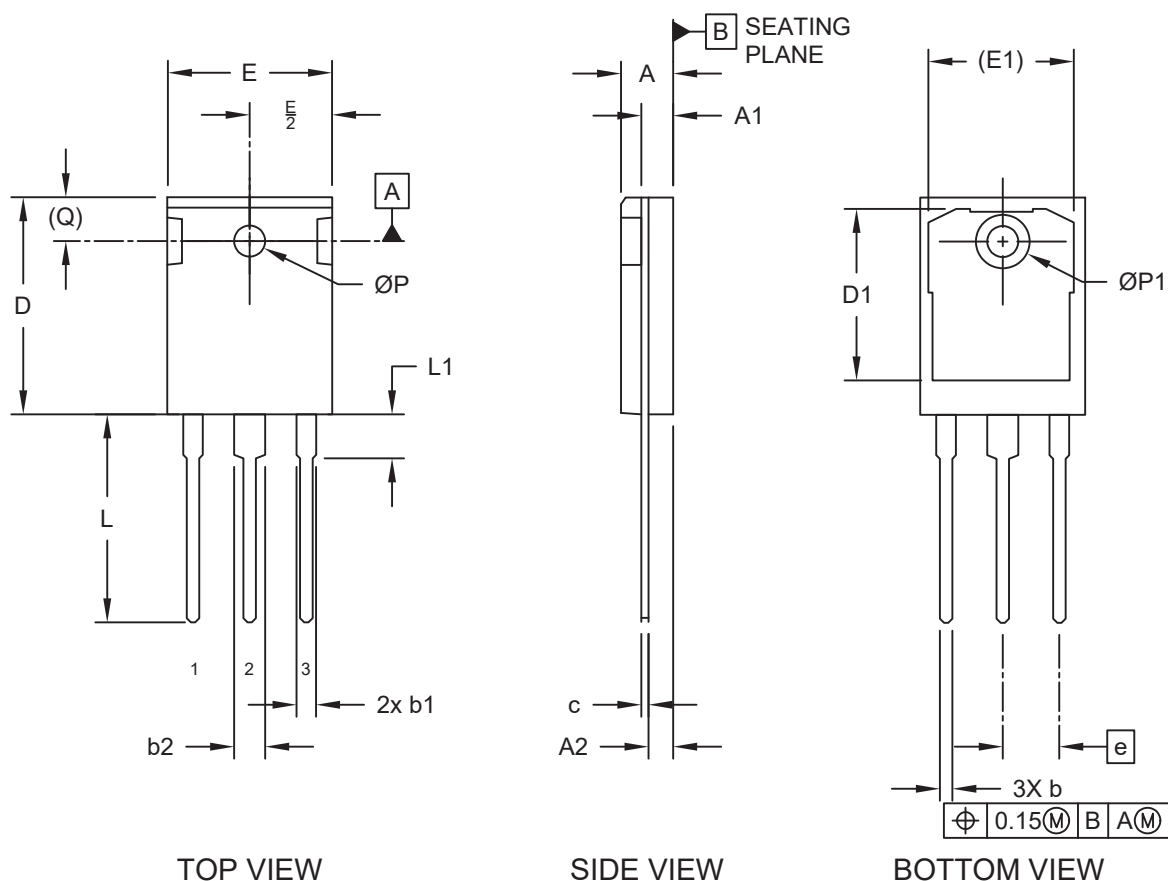
3. Package Specification

This section shows the package specification of this device.

3.1. Package Outline Drawing

The following figure illustrates the TO-247 package outline of this device.

Figure 3-1. Package Outline Drawing



The following table shows the TO-247 dimensions and should be used in conjunction with the package outline drawing.

Table 3-1. TO-247 Dimensions

Dimension Limits		Dimensions (mm)	
		Min.	Max.
Number of leads	N		3
Pitch	e		5.44 BSC
Overall height	A	4.70	5.31
Tab height	A1	1.50	2.49
Seating plane to lead	A2	2.21	2.59
Lead width	b	1.02	1.40
Lead shoulder width (x2)	b1	1.65	2.41
Lead shoulder width	b2	2.87	3.38

Table 3-1. TO-247 Dimensions (continued)

Dimension Limits		Dimensions (mm)	
		Min.	Max.
Lead thickness	c	0.41	0.79
Lead length	L	19.81	20.32
Lead shoulder length	L1	3.99	4.50
Molded body length	D	20.80	21.46
Thermal pad length	D1	16.25	17.65
Total width	E	15.49	16.26
Thermal pad width	E1	13.10	14.50
Hole center to tab edge	Q	6.15 REF	
Hole diameter	ØP	3.51	3.81
Thermal pad hole diameter	ØP1	7.18 REF	

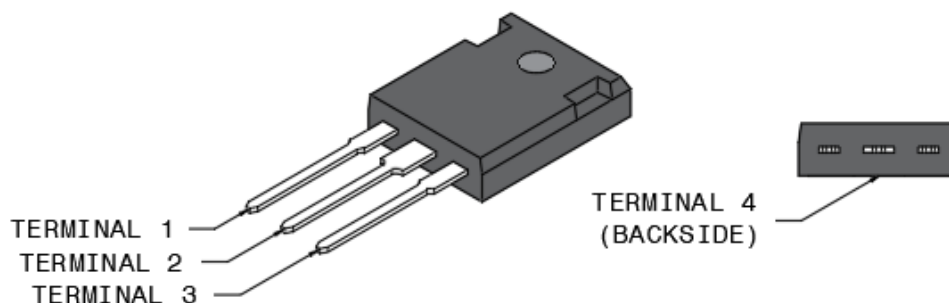
Notes: Dimensioning and tolerancing per ASME Y14.5M

- BSC: Basic dimension—Theoretically exact value shown without tolerances.
- REF: Reference dimension—Usually without tolerance, for information purposes only.

3.2. Terminal Pinout

The following figure illustrates the terminal pinout of this device.

Figure 3-2. Terminal Pinout



The following table shows the electrical signal terminal pinout of this device.

Table 3-2. Electrical Signal Terminal Pinout

Terminal	Definition
TERMINAL 1	Gate
TERMINAL 2	Collector, Diode Cathode
TERMINAL 3	Emitter, Diode Anode
TERMINAL 4	Collector, Diode Cathode

4. 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.

Table 4-1. Revision History

Revision	Date	Description
A	09/2025	Document created.

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