1200 V, 25 A Power MOS 7™ PT IGBT with DQ Diode

APT25GP120BDQ1G

Product Overview

1200 V, 19 A at 50 kHz Power MOS 7 punch-through (PT) IGBT with co-packaged anti-parallel DQ diode, TO-247

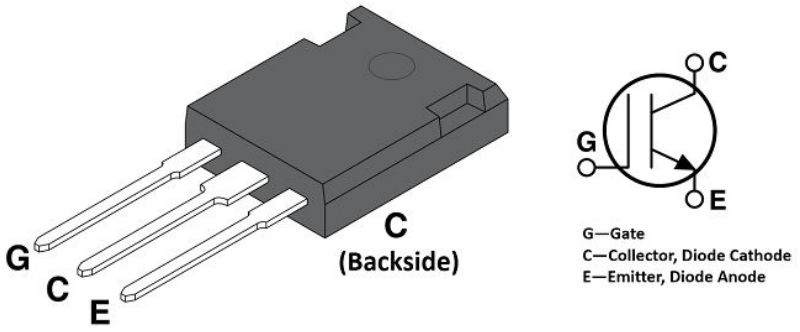


Table 1. Ordering Information

Catalog Part Number (CPN)	Package	Packing Media	Qualification
APT25GP120BDQ1G	TO-247	Tube	Industrial

Features

- Low conduction loss and saturation voltage
- Low gate charge
- Ultrafast tail current shutoff
- Soft recovery
- High operating frequency
- Reverse-bias safe operating area (RBSOA) rated
- RoHS compliant

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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 °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	±30	
I_{C1}	Continuous collector current at T_C = 25 °C	69	A
I_{C2}	Continuous collector current at T_C = 110 °C	33	
I_{CM}	Pulsed collector current[1] at T_C = 150 °C	90	
RBSOA	Reverse-bias safe operating area at T_J = 150 °C and 960 V	90	A
P_D	Total power dissipation T_C = 25 °C	417	W

Note:

1. Repetitive rating: Pulse width and case temperature are limited by 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	0.30	°C/W
$R_{\Theta JC}$	Junction-to-case thermal resistance (diode)		0.81	1.18	
T_J, T_{STG}	Operating and storage junction temperature	–55		150	°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 °C unless otherwise specified.

Table 1-3. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_G = 350 µA	1200			V
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	3	4.5	6	
$V_{CE(ON)}$	Collector-emitter on voltage	V_{GE} = 15 V, I_C = 25 A		3.3	3.9	
		V_{GE} = 15 V, I_C = 25 A, T_J = 125 °C		3.0		
I_{CES}	Collector cut-off current[1]	V_{CE} = 1200 V, V_{GE} = 0 V			350	µA
		V_{CE} = 1200 V, V_{GE} = 0 V, T_J = 125 °C			3500	
I_{GES}	Gate-emitter leakage current	V_{GE} = ±20 V			±100	nA

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Note:

1. I_{CES} includes both IGBT and FRED leakages.

The following table shows the dynamic characteristics of this device. T_C = 25 °C unless otherwise specified.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{GE} = 0 V, V_{CE} = 25 V, ƒ = 1 MHz		2090		pF
C_{res}	Reverse transfer capacitance			40		
C_{oes}	Output capacitance			200		
V_{GEP}	Gate-to-emitter plateau voltage	V_{GE} = 15 V, V_{CE} = 600 V, I_C = 25 A		7.5		V
Q_G	Total gate charge[1]			110		nC
Q_{GE}	Gate-emitter charge			15		
Q_{GC}	Gate-collector ("Miller") charge			50		
RBSOA	Reverse bias safe operating area	T_J = 150 °C, R_G = 5 Ω, V_{GE} = 15 V, V_{CE} = 960 V, L = 100 µH	90			A
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, V_{GE} =15 V, I_C = 25 A, R_G = 5 Ω, T_J = 25 °C		12		ns
t_r	Current rise time			14		
$t_{d(off)}$	Turn-off delay time			70		
t_f	Current fall time			39		
E_{on1}	Turn-on switching energy[2]			500		µJ
E_{on2}	Turn-on switching energy (diode)[3]			1090		
E_{off}	Turn-off switching energy[4]			440		
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, V_{GE} = 15 V, I_C = 25 A, R_G = 5 Ω, T_J = 125 °C		12		ns
t_r	Current rise time			14		
$t_{d(off)}$	Turn-off delay time			110		
t_f	Current fall time			90		
E_{on1}	Turn-on switching energy[2]			500		µJ
E_{on2}	Turn-on switching energy (diode)[3]			1575		
E_{off}	Turn-off switching energy[4]			1185		

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 1-25.)
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 Figures 1-22, 1-23.)
4. E_{off} is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1. (See Figures 1-22, 1-24.)

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1.4 Typical Performance Curves

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

Figure 1-1. Output Characteristics

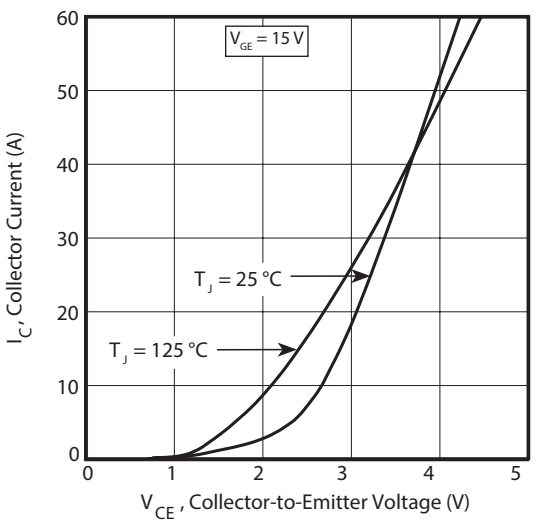


Figure 1-2. Output Characteristics

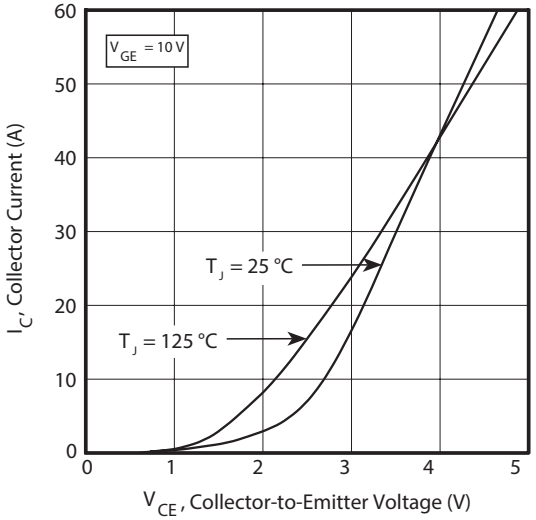


Figure 1-3. Transfer Characteristics

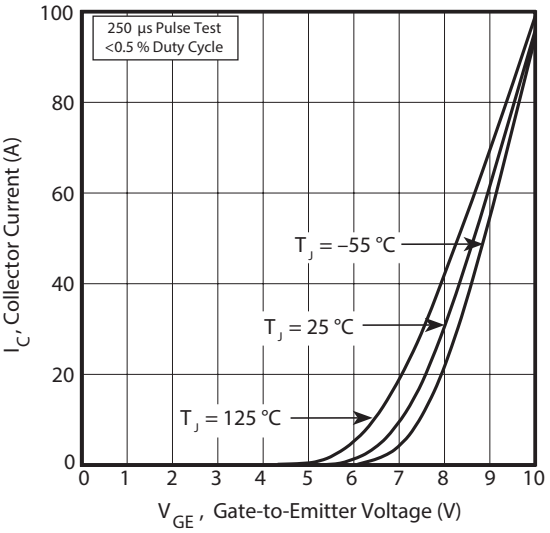
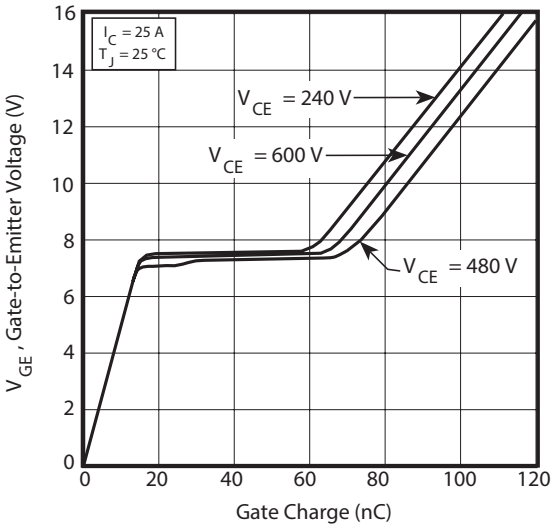


Figure 1-4. Gate Charge



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Figure 1-5. On-State Voltage vs. Gate-to- Emitter Voltage

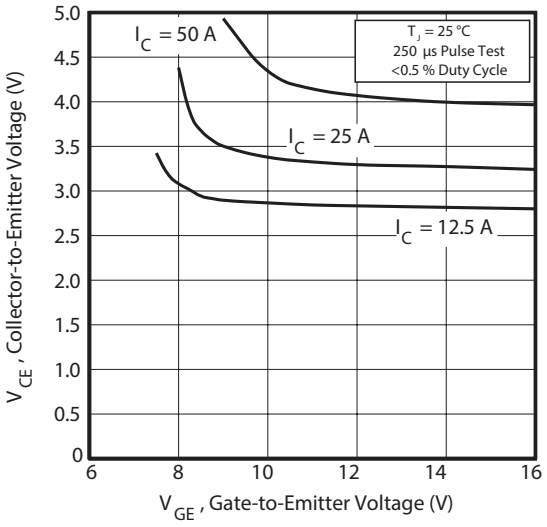


Figure 1-6. On-State Voltage vs. Junction Temperature

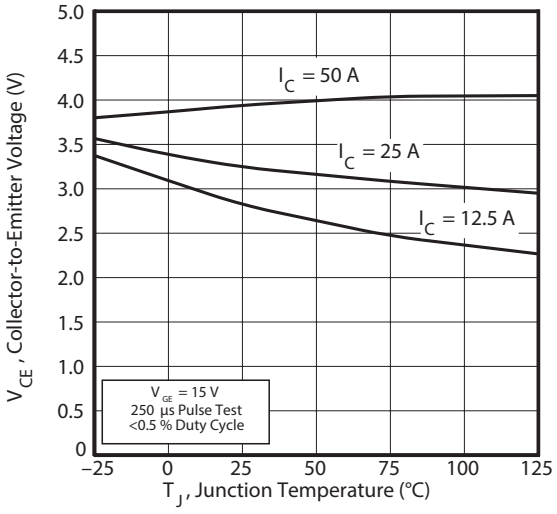


Figure 1-7. Breakdown Voltage vs. Junction Temperature

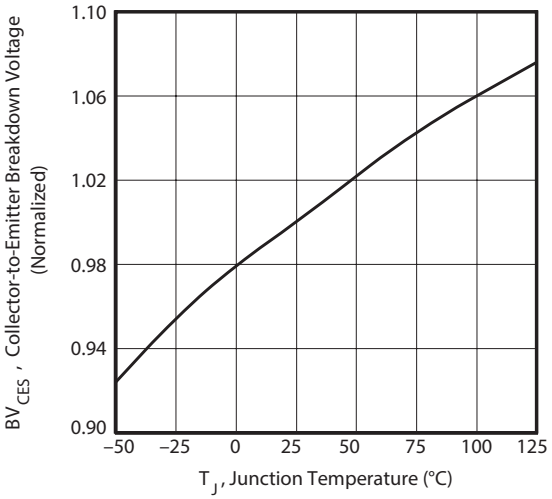
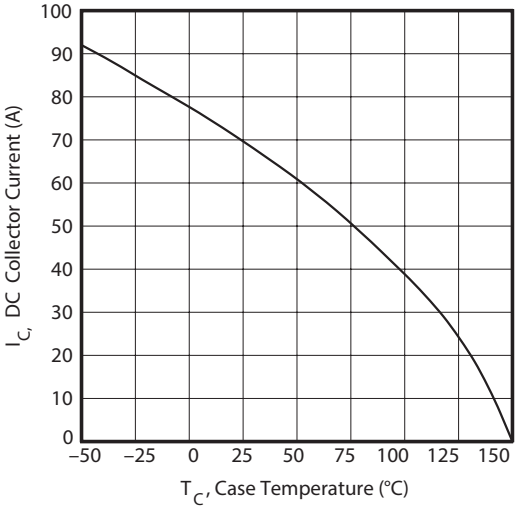


Figure 1-8. DC Collector Current vs. Case Temperature



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Figure 1-9. Turn-On Delay Time vs. Collector Current

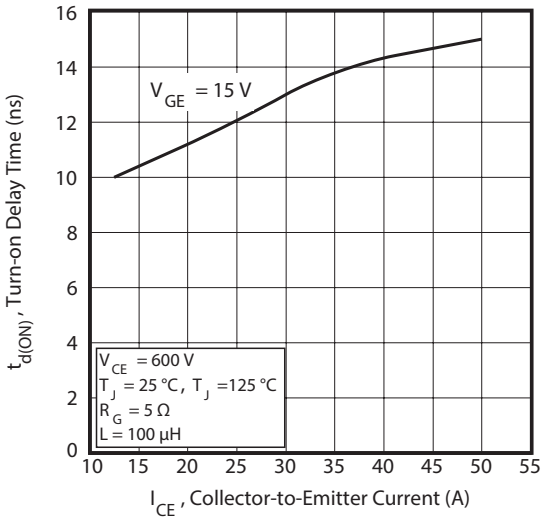


Figure 1-10. Turn-Off Delay Time vs. Collector Current

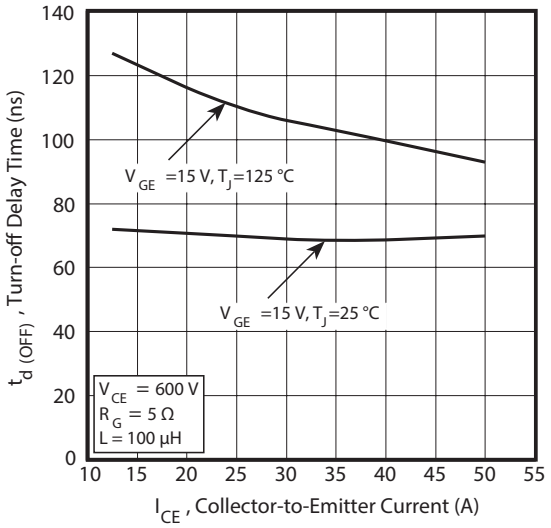


Figure 1-11. Current Rise Time vs. Collector Current

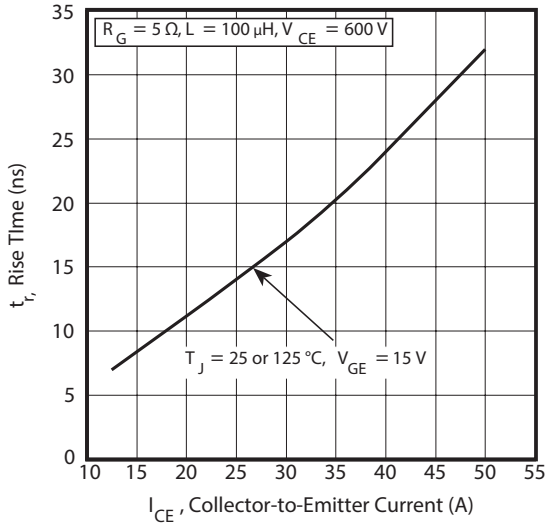
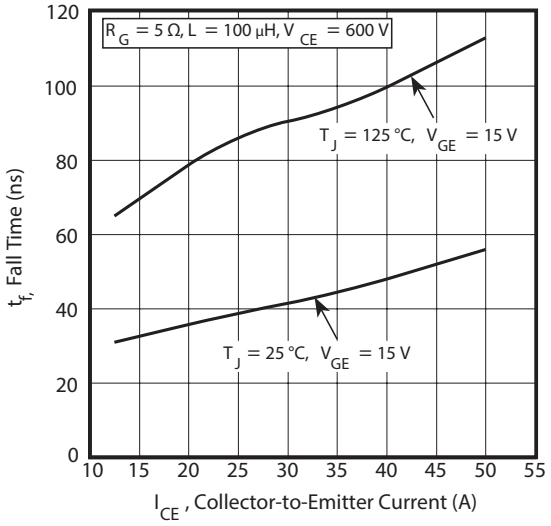


Figure 1-12. Current Rise Time vs. Collector Current



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Figure 1-13. Turn-On Energy Loss vs. Collector Current

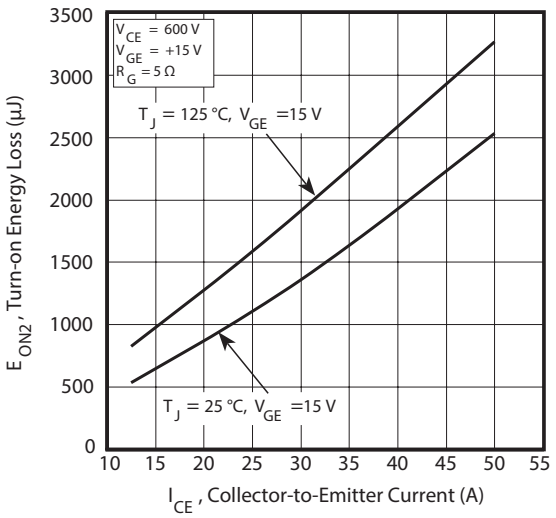


Figure 1-14. Turn-Off Energy Loss vs. Collector Current

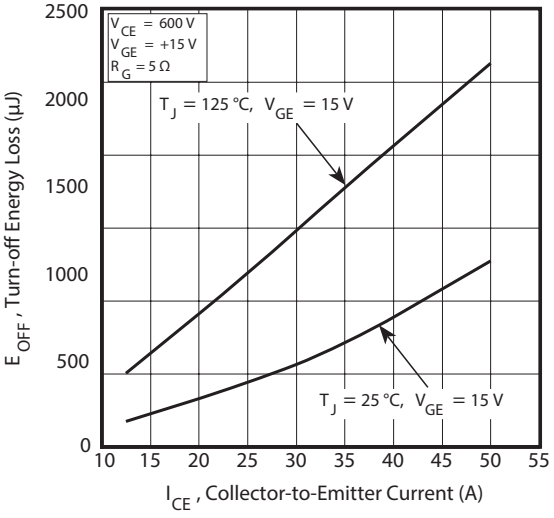


Figure 1-15. Switching Energy Losses vs. Gate Resistance

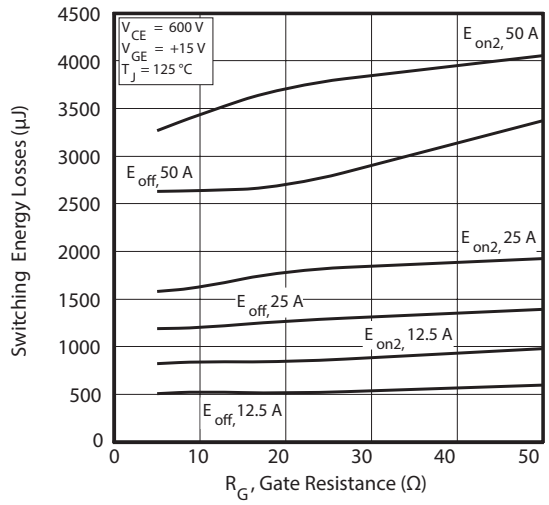
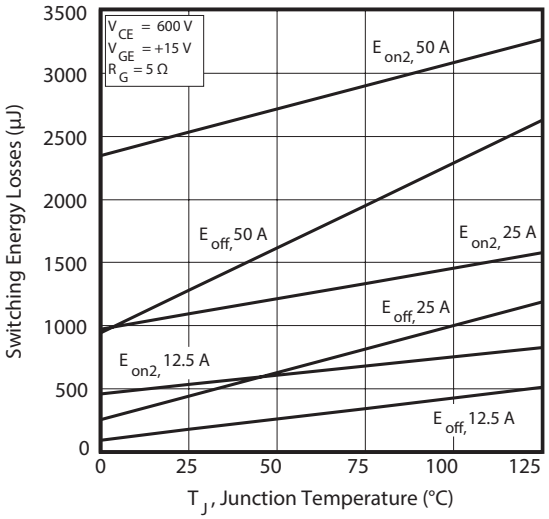


Figure 1-16. Switching Energy Losses vs. Junction Temperature



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Figure 1-17. Capacitance vs. Collector-To-Emitter Voltage

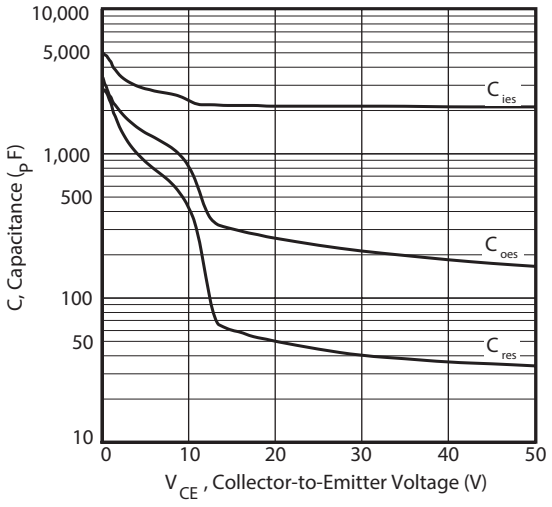


Figure 1-18. Reverse Bias Safe Operating Area

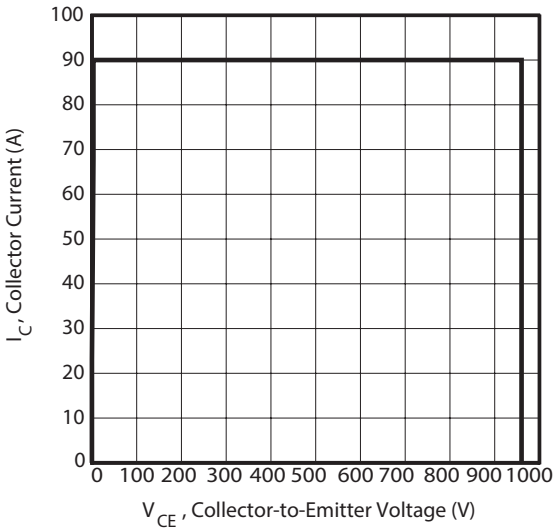


Figure 1-19. Maximum Transient Thermal Impedance

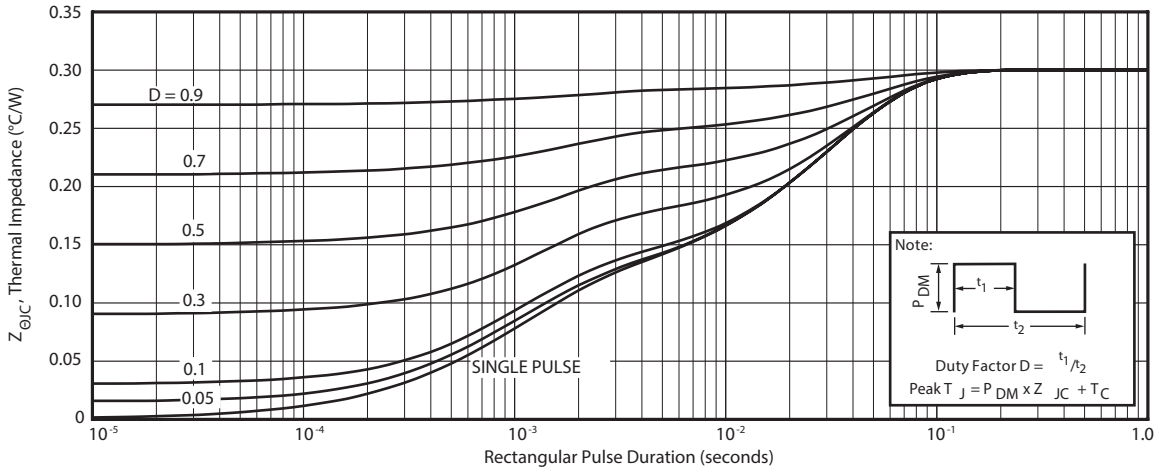
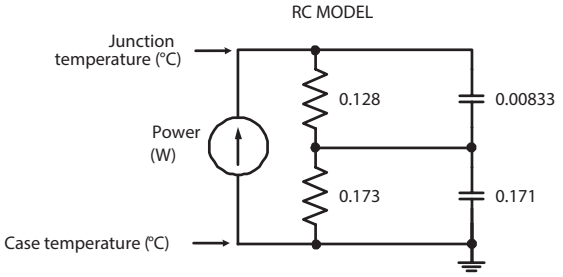


Figure 1-20. Transient Thermal Impedance Model



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Figure 1-21. Operating Frequency vs. Collector Current

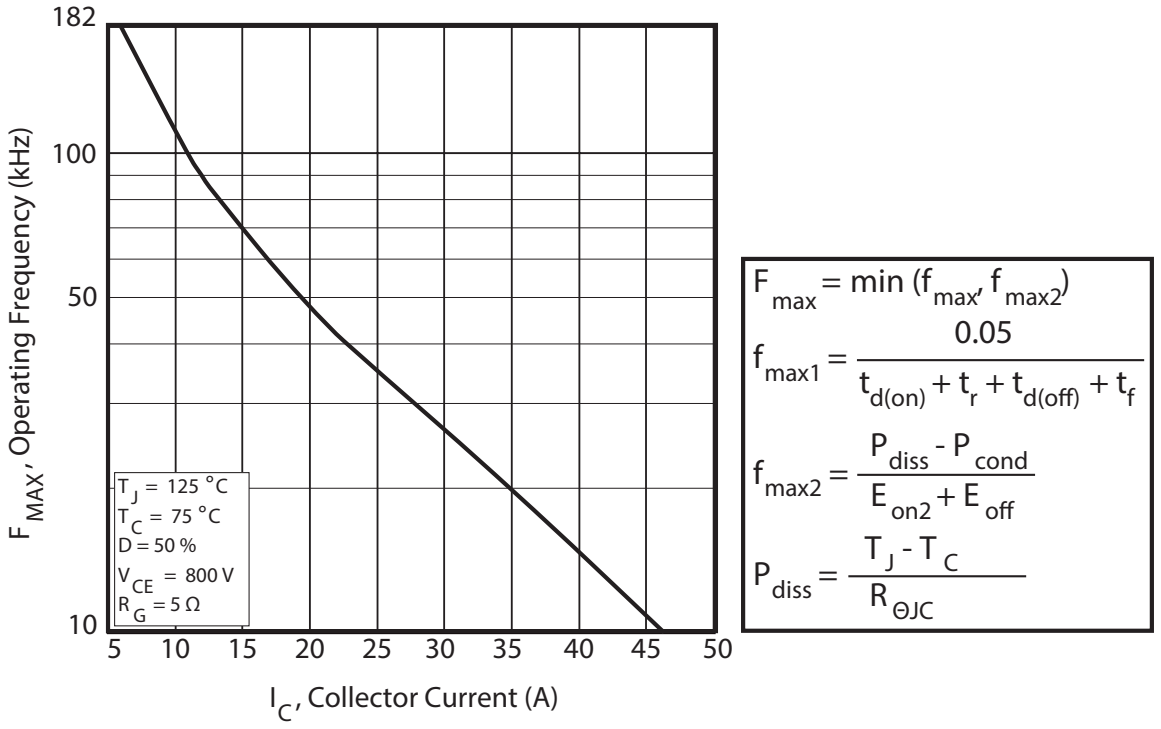


Figure 1-22. Inductive Switching Test Circuit

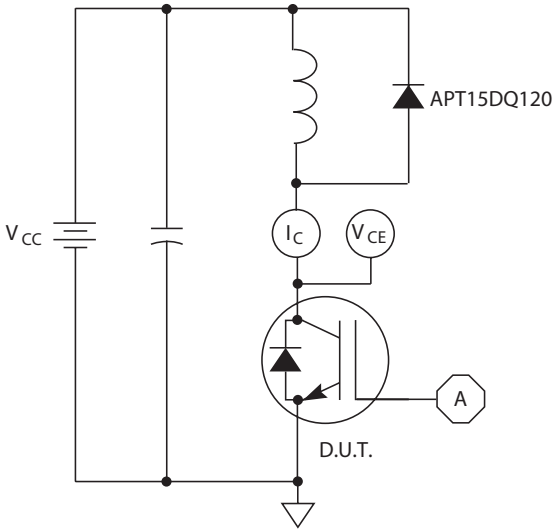
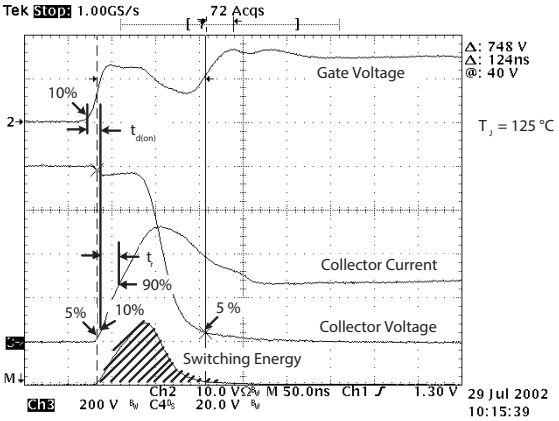


Figure 1-23. Turn-on Switching Waveforms and Definitions



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Figure 1-24. Turn-off Switching Waveforms and Definitions

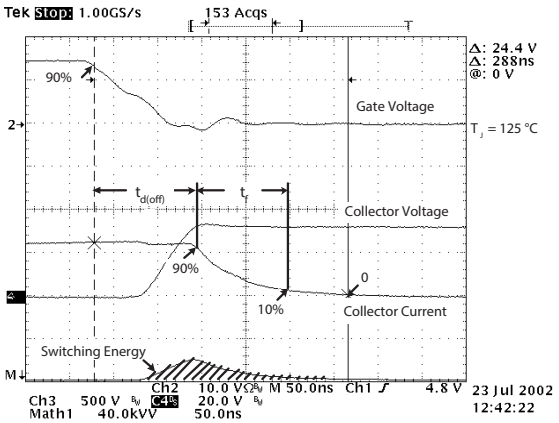
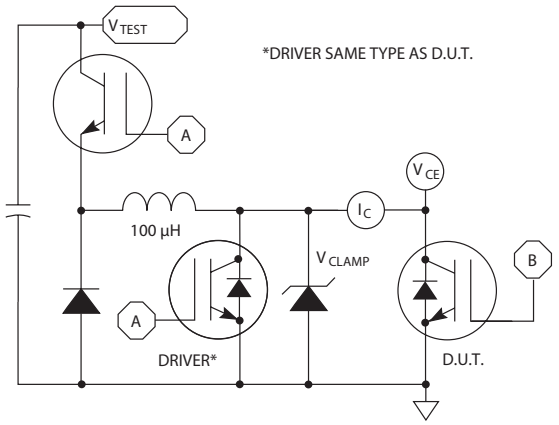


Figure 1-25. E_{ON1} Test Circuit



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

This section shows the specifications of the Ultrafast Soft Recovery Anti-Parallel Diode.

2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the anti-parallel diode. T_C = 25 °C unless otherwise specified.

Table 2-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
I_F(AV)	Maximum average forward current (T_C = 127 °C, duty cycle = 0.5)	15	A
I_F(RMS)	RMS forward current (square wave, duty cycle = 0.5)	29	
I_{FSM}	Non-repetitive forward surge current (T_J = 45 °C, 8.3 ms)	110	

2.2 Electrical Performance

The following table shows the static characteristics of the anti-parallel diode. T_C = 25 °C unless otherwise specified.

Table 2-2. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	I_F = 25 A		3.24		V
		I_F = 50 A		4.03		
		I_F = 25 A, T_J = 125 °C		2.91		

The following table shows the dynamic characteristics of the anti-parallel diode. T_C = 25 °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 A, di_F/dt = –100 A/µs, V_R = 30 V		21		ns
t_{rr}	Reverse recovery time	I_F = 15 A, di_F/dt = –200 A/µs, V_R = 800 V		240		
Q_{rr}	Reverse recovery charge			260		nC
I_{RRM}	Maximum reverse recovery current			3		A
t_{rr}	Reverse recovery time	I_F = 15 A, di_F/dt = –200 A/µs, V_R = 800 V, T_C = 125 °C		290		ns
Q_{rr}	Reverse recovery charge			960		nC
I_{RRM}	Maximum reverse recovery current			6		A
t_{rr}	Reverse recovery time	I_F = 15 A, di_F/dt = –1000 A/µs, V_R = 800 V, T_C = 125 °C		130		ns
Q_{rr}	Reverse recovery charge			1340		nC
I_{RRM}	Maximum reverse recovery current			19		A

2.3 Typical Performance Curves

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

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Figure 2-1. Maximum Transient Thermal Impedance

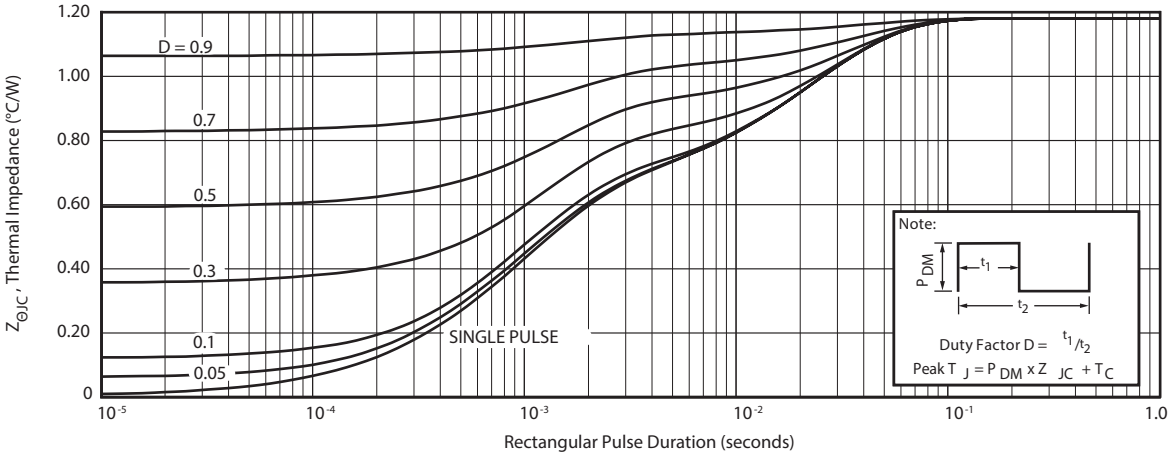


Figure 2-2. Transient Thermal Impedance Model

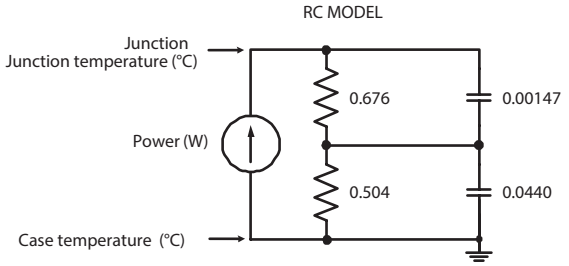


Figure 2-3. Forward Current vs. Forward Voltage

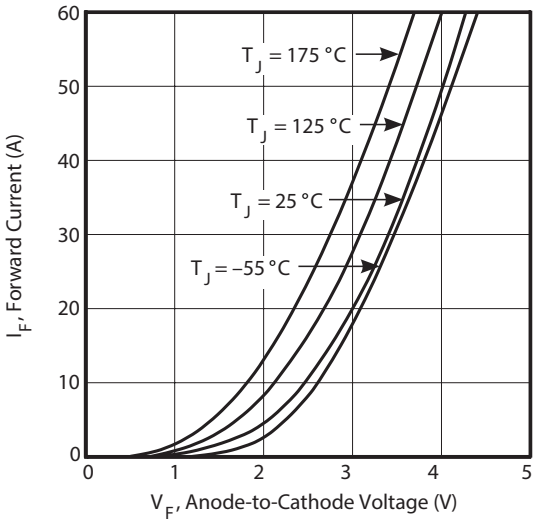
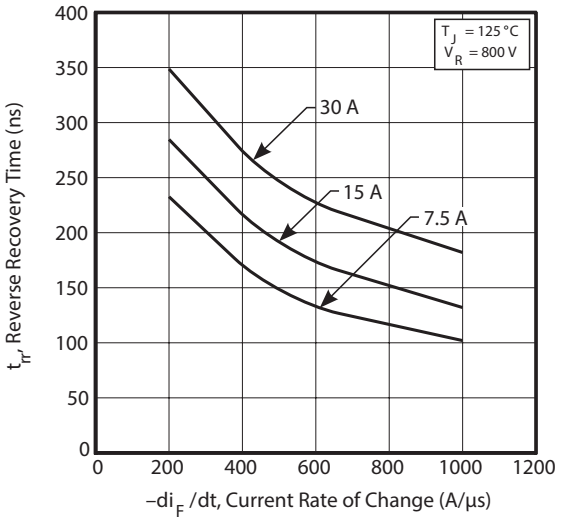


Figure 2-4. Reverse Recovery Time vs. Current Rate of Change



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Figure 2-5. Reverse Recovery Charge vs. Current Rate of Change

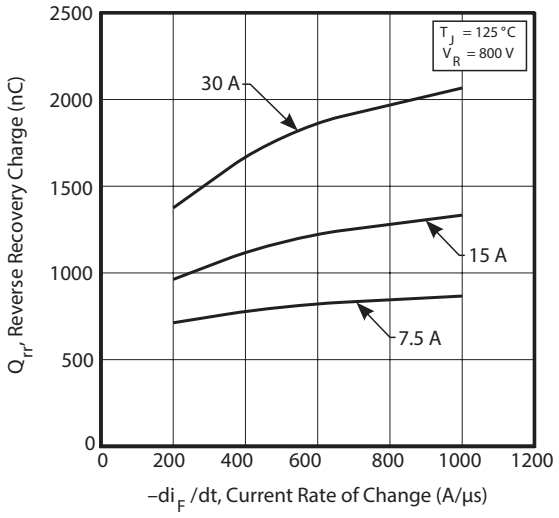


Figure 2-6. Reverse Recovery Charge vs. Current Rate of Change

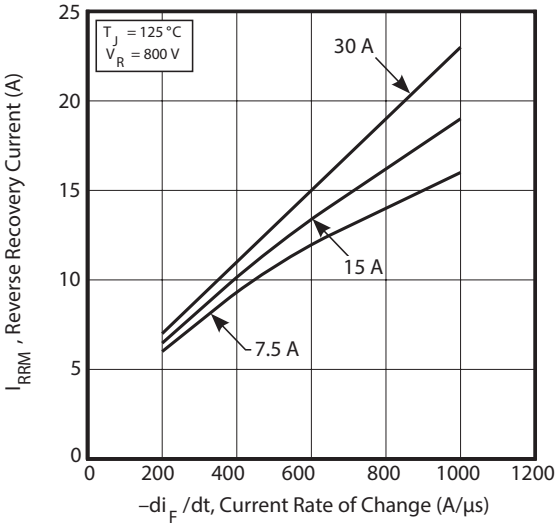


Figure 2-7. Dynamic Parameters vs. Junction Temperature

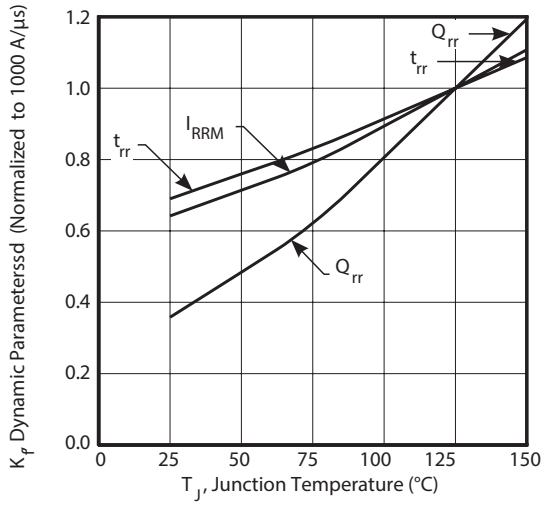
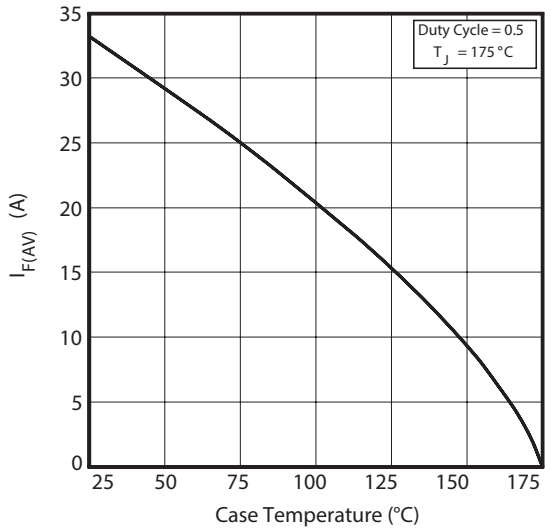
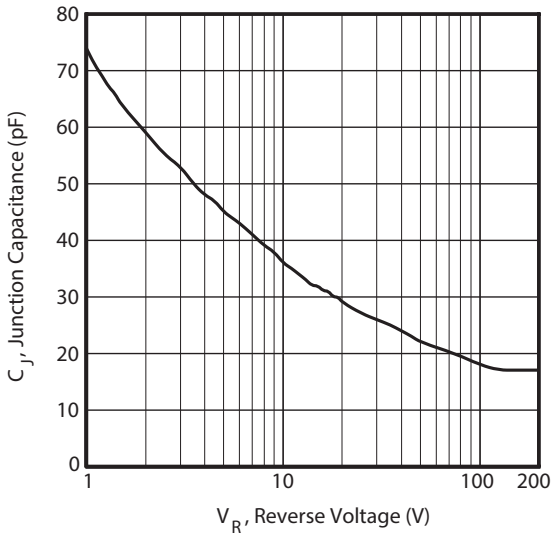


Figure 2-8. Maximum Average Forward Current vs. Case Temperature



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Figure 2-9. Junction Capacitance vs. Reverse Voltage



The following figure shows the diode test circuit of this device.

Figure 2-10. Diode Test Circuit

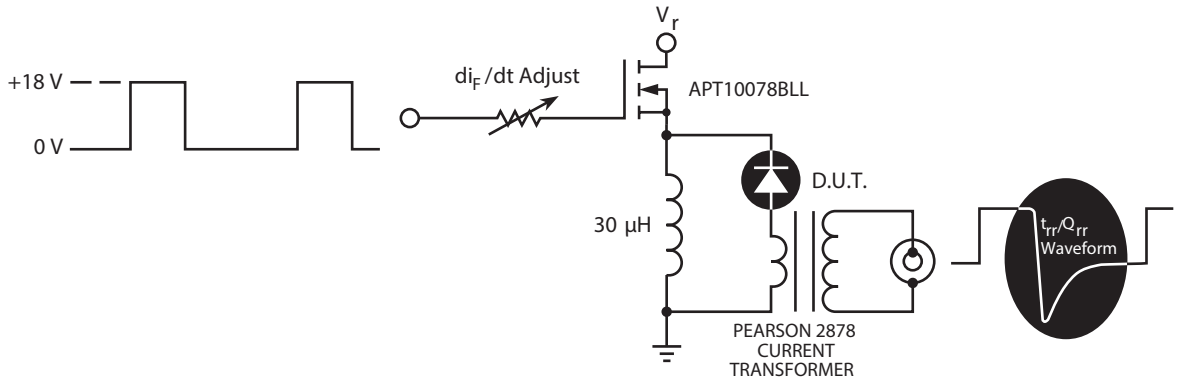
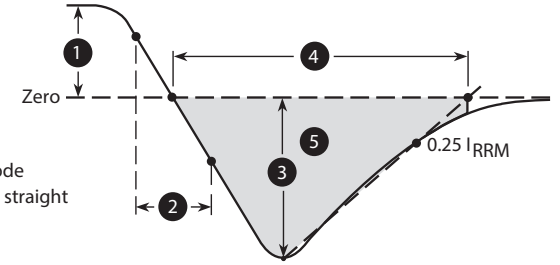


Figure 2-11. Diode Reverse Recovery Waveform and Definitions



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 • I_{RRM} passes through zero.
5. Q_{rr} — Area under the curve defined by I_{RRM} and t_{rr}.

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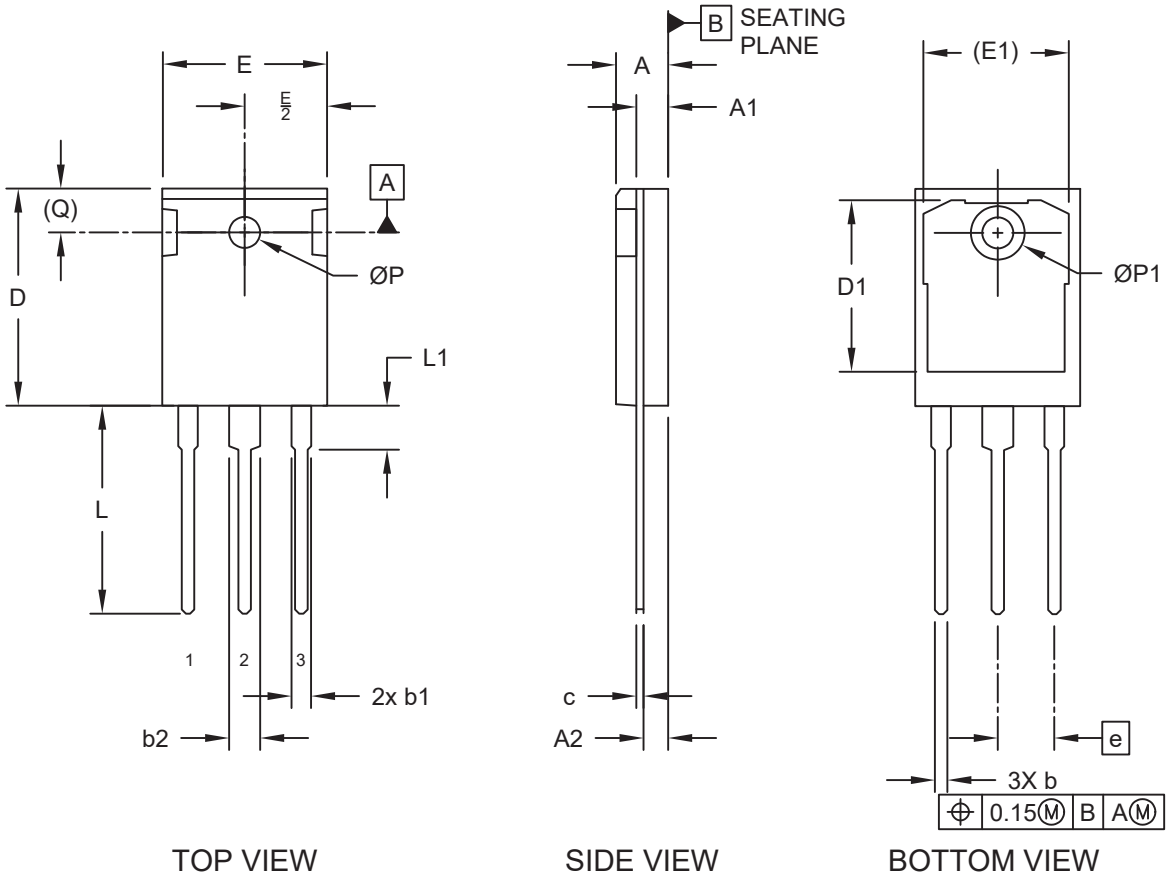
3. Package Specification

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.	Nom.	Max.
Number of leads	N	3		
Pitch	e	5.44 BSC		
Overall height	A	4.70	**0.197**	5.31
Tab height	A1	1.50	**0.0785**	2.49
Seating plane to lead	A2	2.21	**0.0945**	2.59
Lead width	b	1.02	**0.0475**	1.40
Lead shoulder width (×2)	b1	1.65	**0.0745**	2.41

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.....continued

Dimension Limits		Dimensions (mm)		
		Min.	Nom.	Max.
Lead shoulder width	b2	2.87	**0.118**	3.38
Lead thickness	c	0.41	**0.0235**	0.79
Lead length	L	19.81	**0.790**	20.32
Lead shoulder length	L1	3.99	**0.167**	4.50
Molded body length	D	20.80	**0.832**	21.46
Thermal pad length	D1	16.25	**0.6695**	17.65
Total width	E	15.49	**0.625**	16.26
Thermal pad width	E1	13.10	**0.551**	14.50
Hole center to tab edge	Q		6.15 REF	
Hole diameter	ØP	3.51	**0.144**	3.81
Thermal pad hole diameter	ØP1	**0.280**	**0.2875**	**0.295**

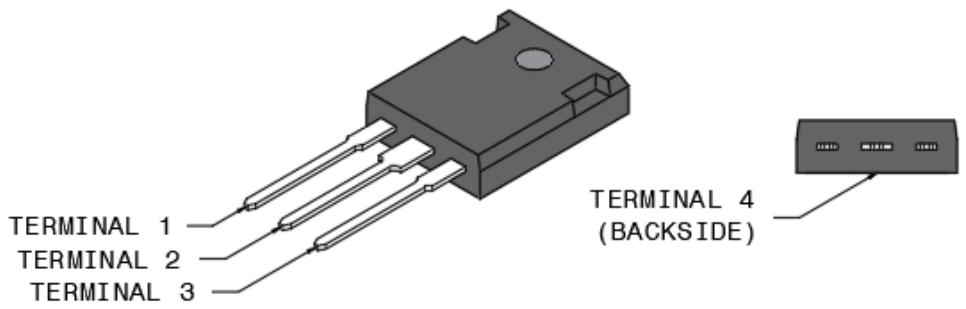
Notes: Dimensioning and tolerancing per ASME Y14.5M

- 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

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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	04/2024	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00005568A, which replaces the previous Microsemi literature number 050-7457.
Initial release (Microsemi Revision A)	06/2005	Initial release.

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