

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

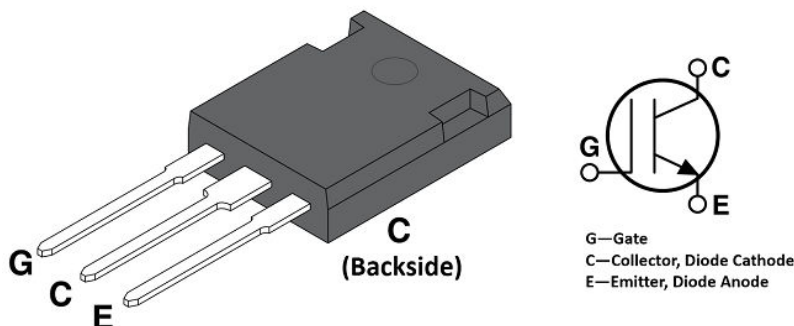


Table 1. Ordering Information

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

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	± 30	
I_{C1}	Continuous collector current at $T_C = 25\text{ }^\circ\text{C}$	69	A
I_{C2}	Continuous collector current at $T_C = 110\text{ }^\circ\text{C}$	33	
I_{CM}	Pulsed collector current ¹ at $T_C = 150\text{ }^\circ\text{C}$	90	
RBSOA	Reverse-bias safe operating area at $T_J = 150\text{ }^\circ\text{C}$ and 960 V	90	A
P_D	Total power dissipation $T_C = 25\text{ }^\circ\text{C}$	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	$^\circ\text{C/W}$
$R_{\theta JC}$	Junction-to-case thermal resistance (diode)		0.81	1.18	
T_J, T_{STG}	Operating and storage junction temperature	-55		150	$^\circ\text{C}$
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
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}, I_G = 350\text{ }\mu\text{A}$	1200			V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	3	4.5	6	
$V_{CE(ON)}$	Collector-emitter on voltage	$V_{GE} = 15\text{ V}, I_C = 25\text{ A}$		3.3	3.9	
		$V_{GE} = 15\text{ V}, I_C = 25\text{ A}, T_J = 125\text{ }^\circ\text{C}$		3.0		
I_{CES}	Collector cut-off current ¹	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$			350	μA
		$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$			3500	
I_{GES}	Gate-emitter leakage current	$V_{GE} = \pm 20\text{ V}$			± 100	nA

Note:

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

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	$V_{GE} = 0\text{ V}, V_{CE} = 25\text{ V}, f = 1\text{ MHz}$		2090		pF	
C_{res}	Reverse transfer capacitance			40			
C_{oes}	Output capacitance			200			
V_{GEP}	Gate-to-emitter plateau voltage	$V_{GE} = 15\text{ V}, V_{CE} = 600\text{ V}, I_C = 25\text{ A}$		7.5		V	
Q_G	Total gate charge ¹			110			
Q_{GE}	Gate-emitter charge			15			
Q_{GC}	Gate-collector ("Miller") charge			50			
RBSOA	Reverse bias safe operating area	$T_J = 150\text{ }^\circ\text{C}, R_G = 5\text{ }\Omega, V_{GE} = 15\text{ V}, V_{CE} = 960\text{ V}, L = 100\text{ }\mu\text{H}$	90			A	
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 25\text{ A}, R_G = 5\text{ }\Omega, T_J = 25\text{ }^\circ\text{C}$		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	$V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 25\text{ A}, R_G = 5\text{ }\Omega, T_J = 125\text{ }^\circ\text{C}$		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.)

1.4 Typical Performance Curves

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

Figure 1-1. Output Characteristics

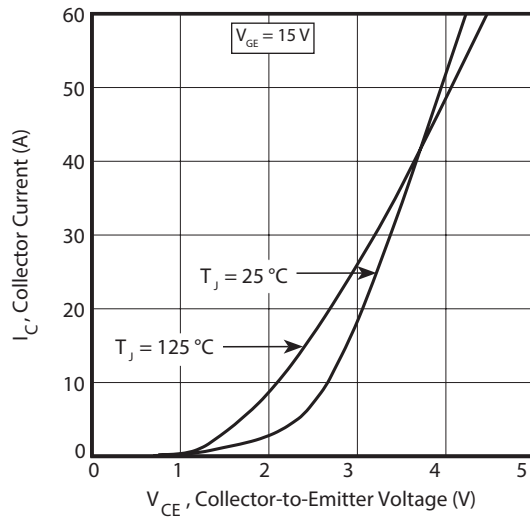


Figure 1-2. Output Characteristics

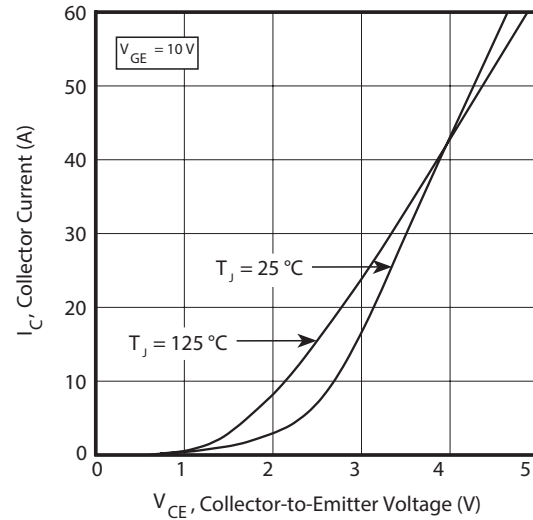


Figure 1-3. Transfer Characteristics

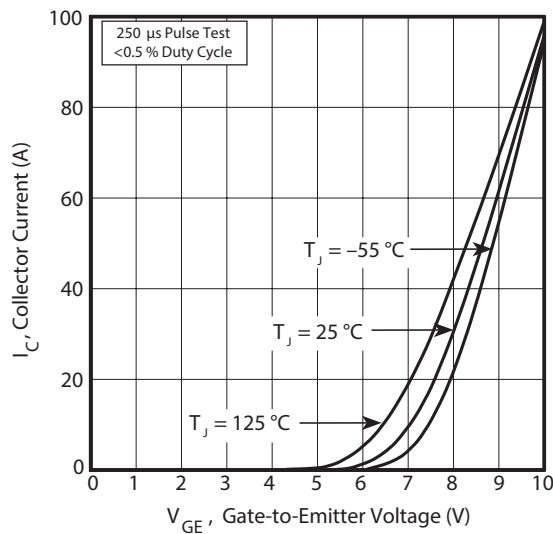


Figure 1-4. Gate Charge

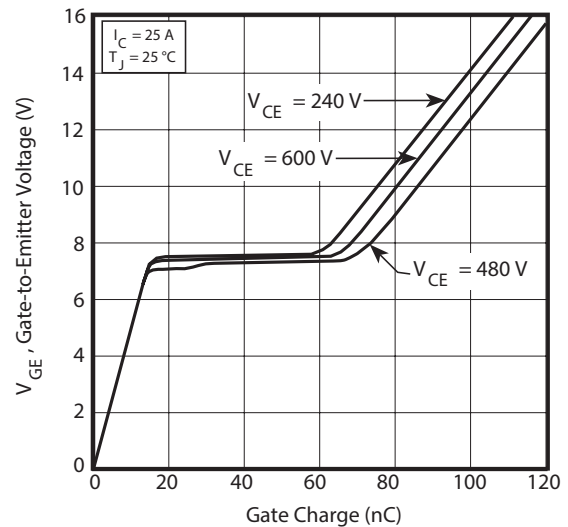


Figure 1-5. On-State Voltage vs. Gate-to- Emitter Voltage

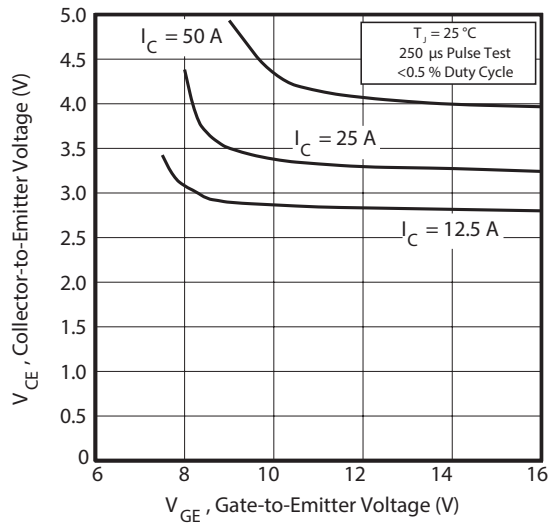


Figure 1-6. On-State Voltage vs. Junction Temperature

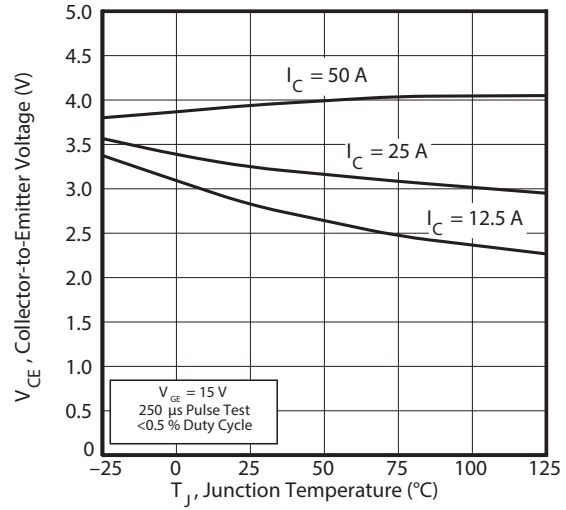


Figure 1-7. Breakdown Voltage vs. Junction Temperature

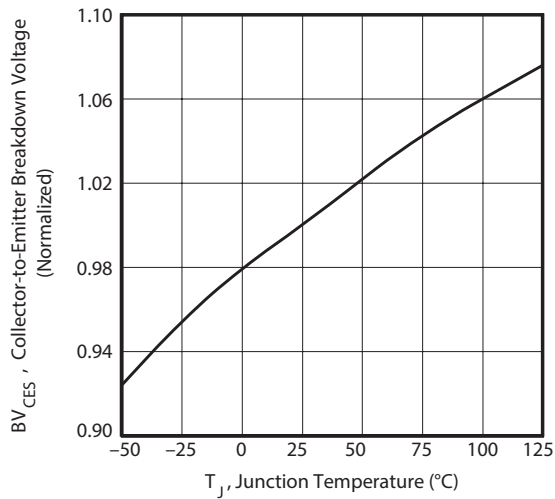


Figure 1-8. DC Collector Current vs. Case Temperature

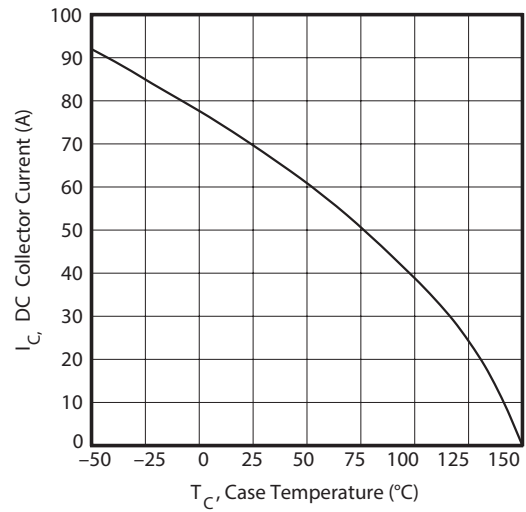


Figure 1-9. Turn-On Delay Time vs. Collector Current

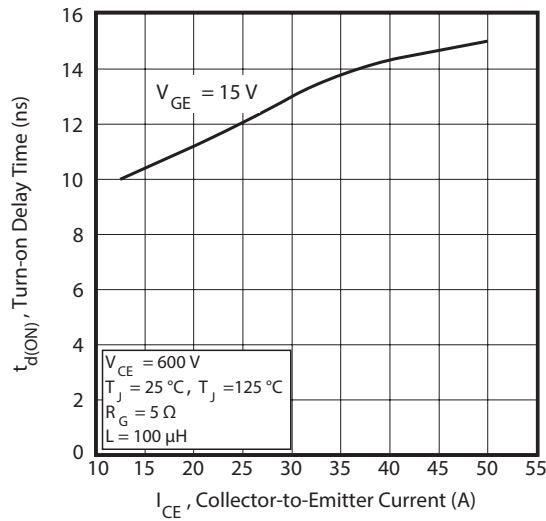


Figure 1-10. Turn-Off Delay Time vs. Collector Current

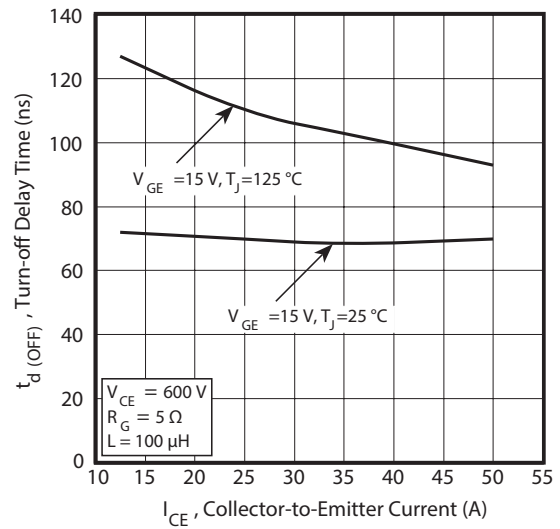


Figure 1-11. Current Rise Time vs. Collector Current

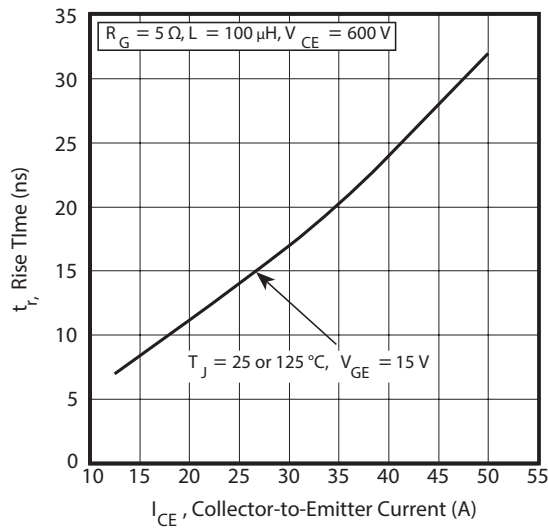


Figure 1-12. Current Rise Time vs. Collector Current

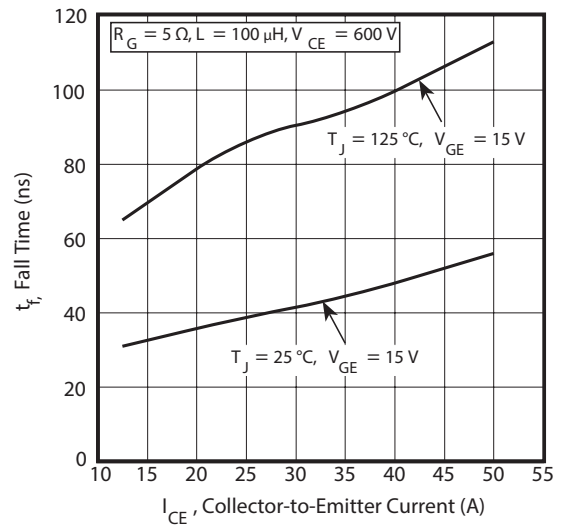


Figure 1-13. Turn-On Energy Loss vs. Collector Current

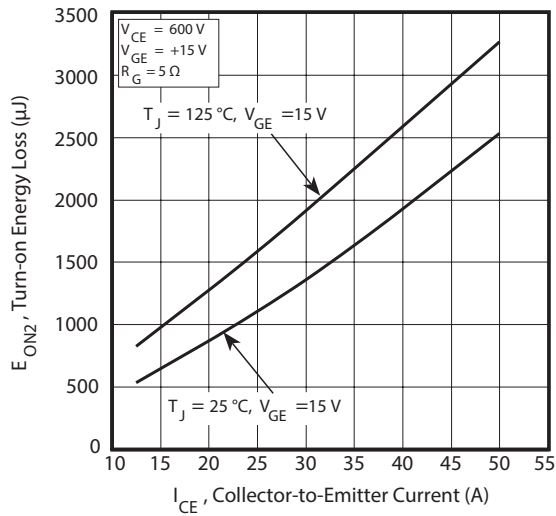


Figure 1-14. Turn-Off Energy Loss vs. Collector Current

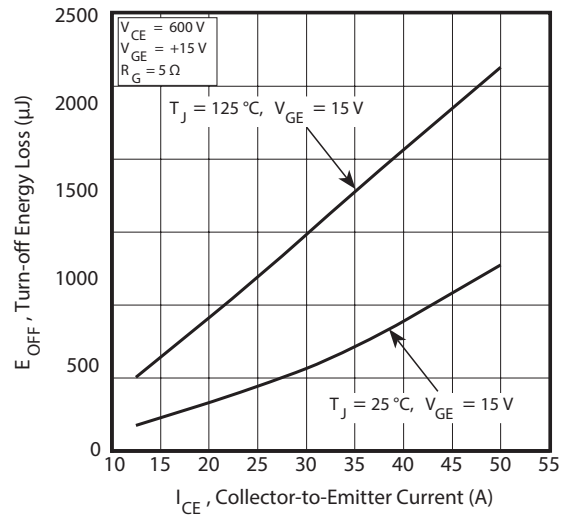


Figure 1-15. Switching Energy Losses vs. Gate Resistance

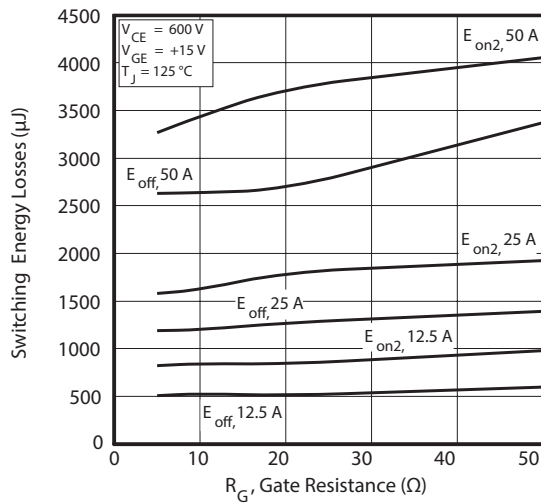


Figure 1-16. Switching Energy Losses vs. Junction Temperature

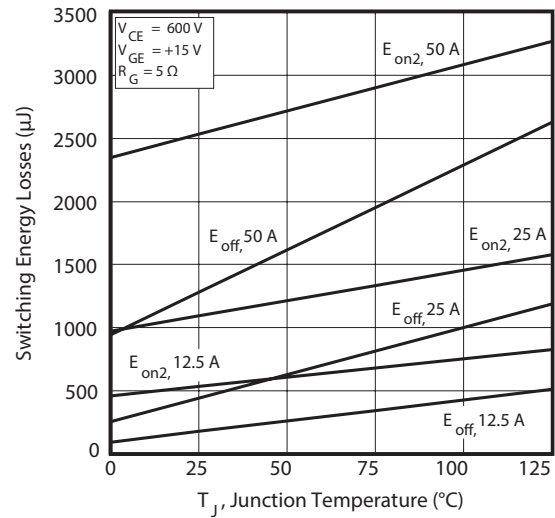


Figure 1-17. Capacitance vs. Collector-To-Emitter Voltage **Figure 1-18. Reverse Bias Safe Operating Area**

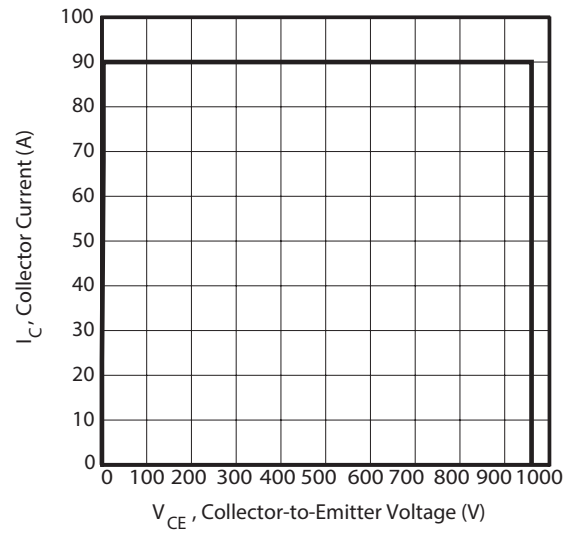
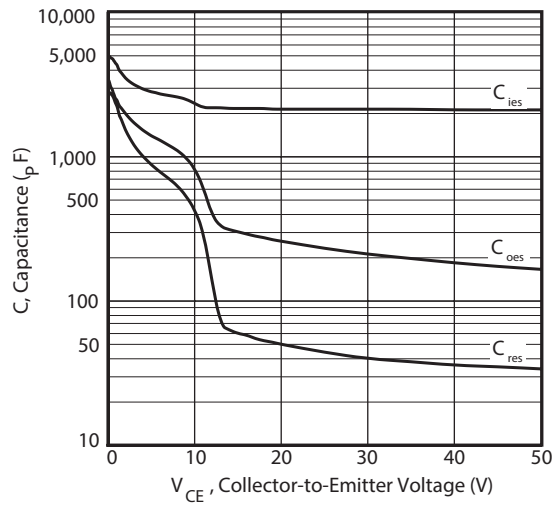


Figure 1-19. Maximum Transient Thermal Impedance

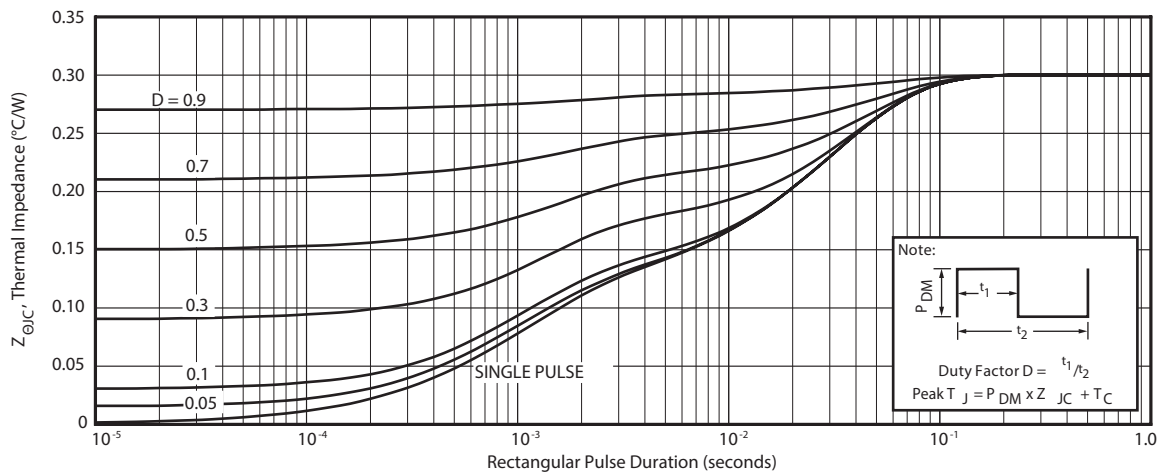


Figure 1-20. Transient Thermal Impedance Model

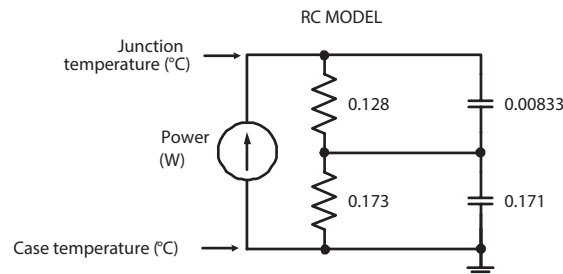


Figure 1-21. Operating Frequency vs. Collector Current

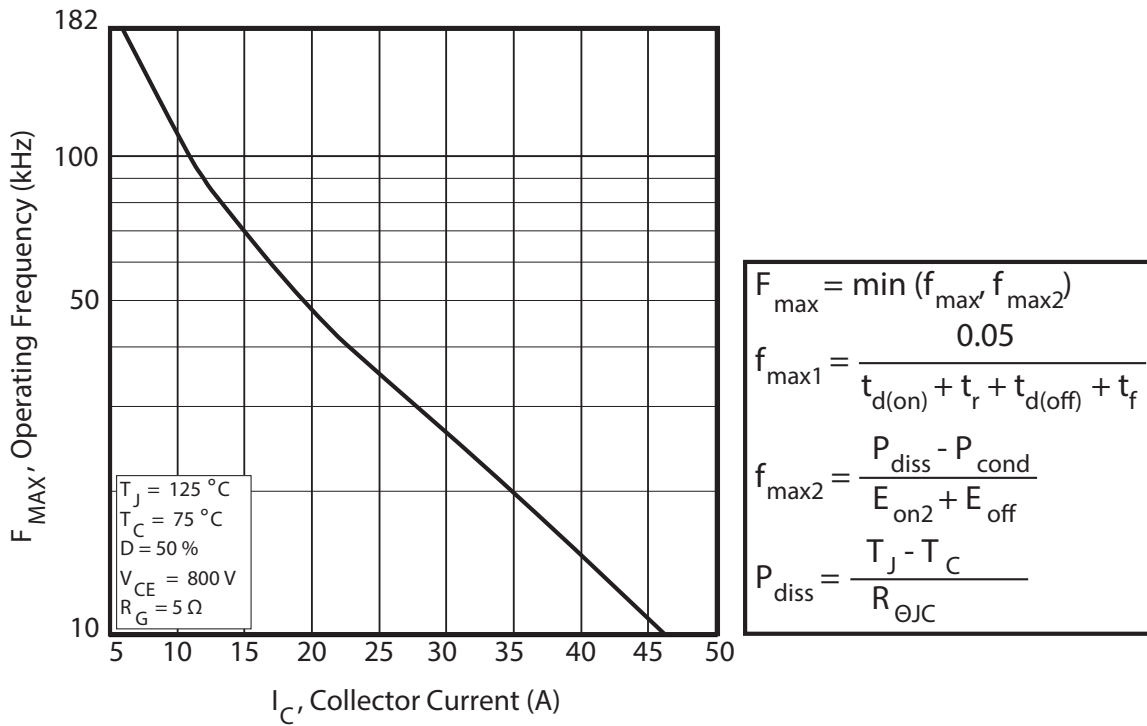


Figure 1-22. Inductive Switching Test Circuit

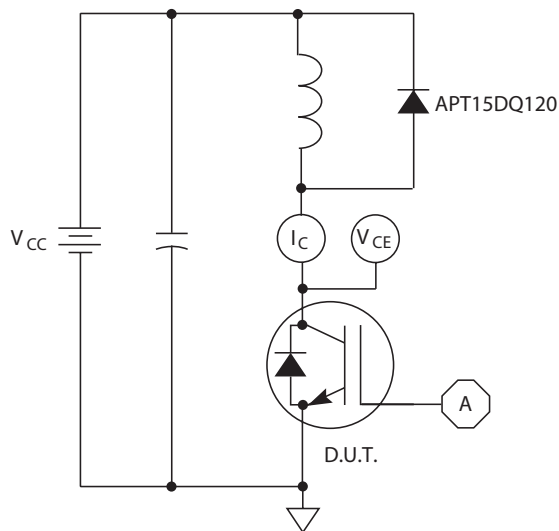


Figure 1-23. Turn-on Switching Waveforms and Definitions

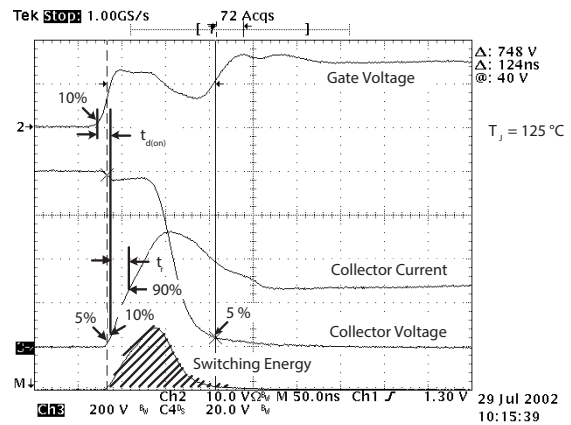


Figure 1-24. Turn-off Switching Waveforms and Definitions

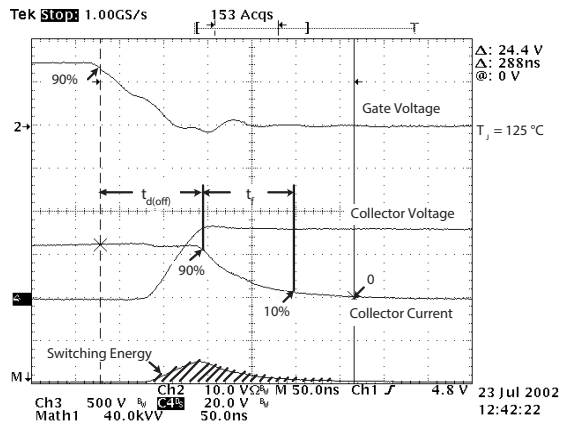
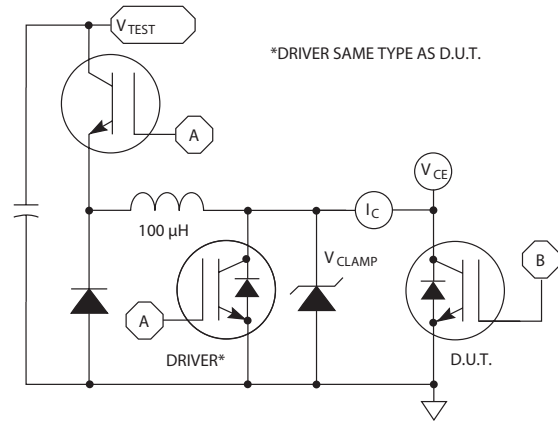


Figure 1-25. E_{ON1} Test Circuit



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. $T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Table 2-1. Absolute Maximum Ratings

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

2.2 Electrical Performance

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

Table 2-2. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	$I_F = 25\text{ A}$		3.24		V
		$I_F = 50\text{ A}$		4.03		
		$I_F = 25\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$		2.91		

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	$I_F = 1\text{ A}$, $di_F/dt = -100\text{ A}/\mu\text{s}$, $V_R = 30\text{ V}$		21		ns
t_{rr}	Reverse recovery time			240		
Q_{rr}	Reverse recovery charge			260		
I_{RRM}	Maximum reverse recovery current	$I_F = 15\text{ A}$, $di_F/dt = -200\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$, $T_C = 125\text{ }^\circ\text{C}$		3		A
t_{rr}	Reverse recovery time			290		ns
Q_{rr}	Reverse recovery charge			960		nC
I_{RRM}	Maximum reverse recovery current	$I_F = 15\text{ A}$, $di_F/dt = -1000\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$, $T_C = 125\text{ }^\circ\text{C}$		6		A
t_{rr}	Reverse recovery time			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.

Figure 2-1. Maximum Transient Thermal Impedance

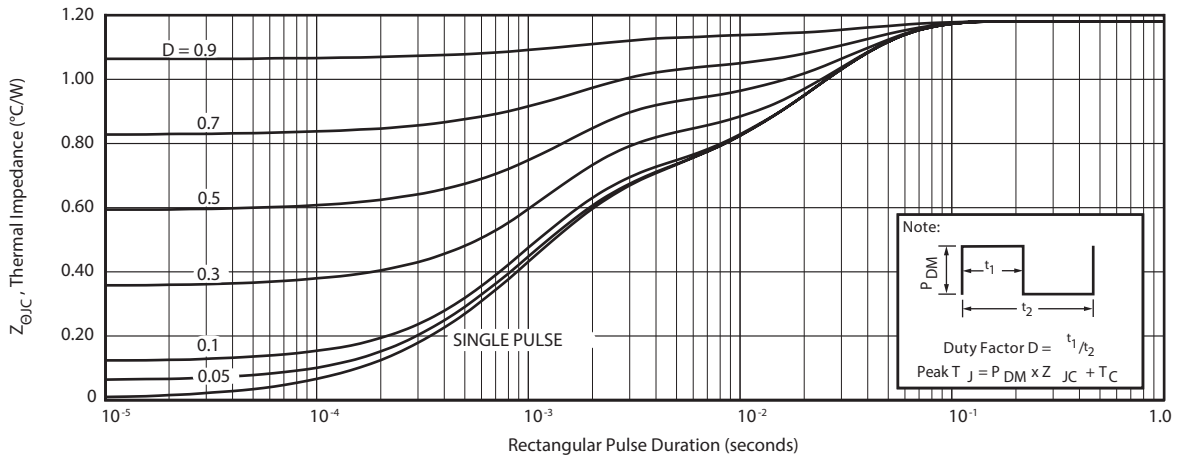


Figure 2-2. Transient Thermal Impedance Model

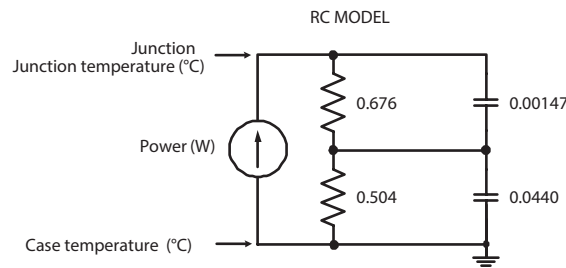


Figure 2-3. Forward Current vs. Forward Voltage

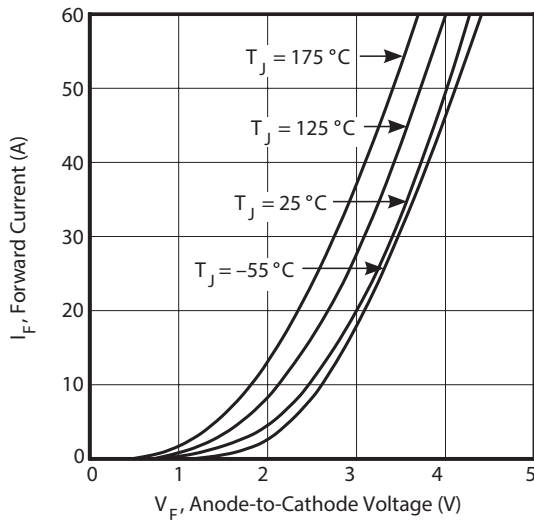


Figure 2-4. Reverse Recovery Time vs. Current Rate of Change

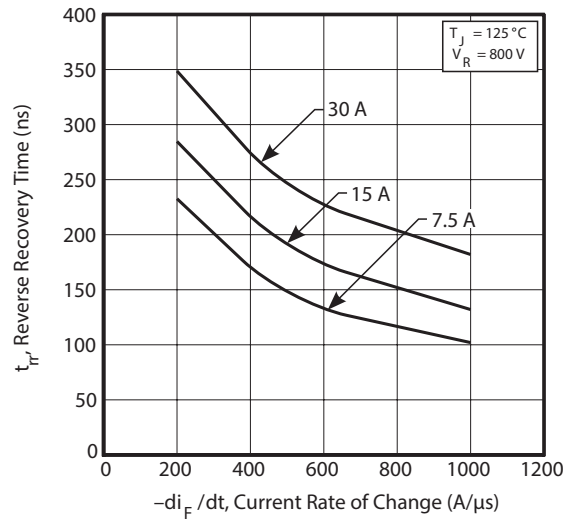


Figure 2-5. Reverse Recovery Charge vs. Current Rate of Change

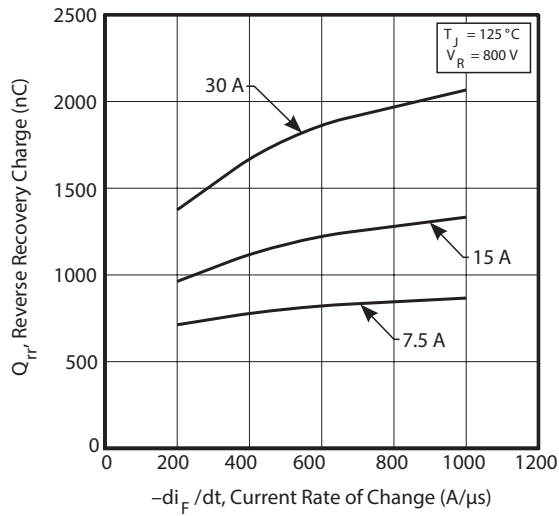


Figure 2-6. Reverse Recovery Charge vs. Current Rate of Change

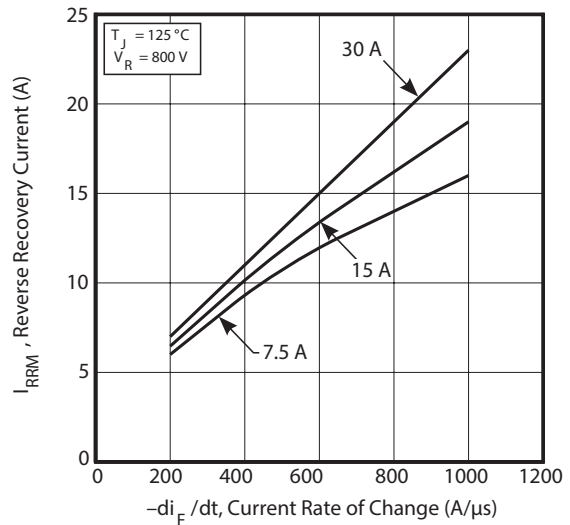


Figure 2-7. Dynamic Parameters vs. Junction Temperature

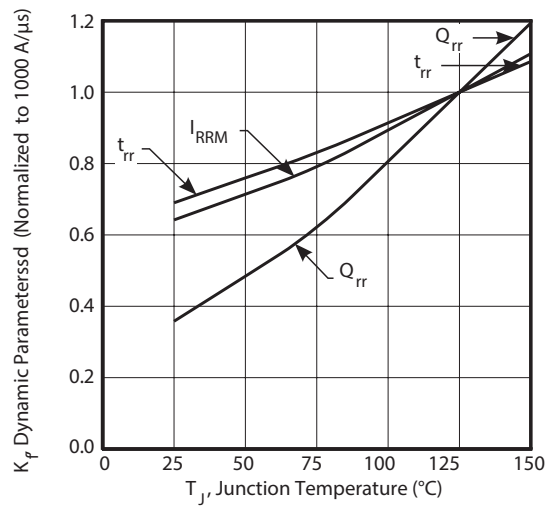


Figure 2-8. Maximum Average Forward Current vs. Case Temperature

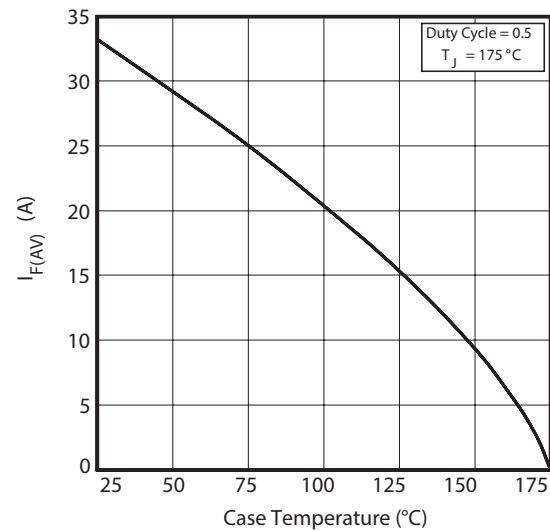
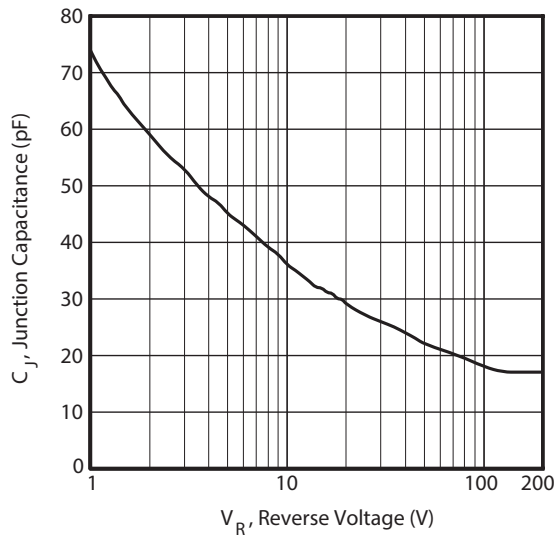


Figure 2-9. Junction Capacitance vs. Reverse Voltage



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

Figure 2-10. Diode Test Circuit

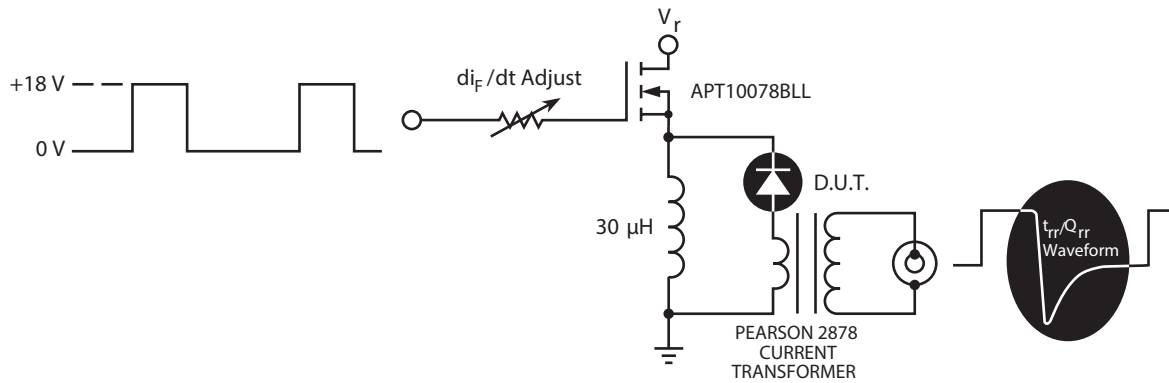
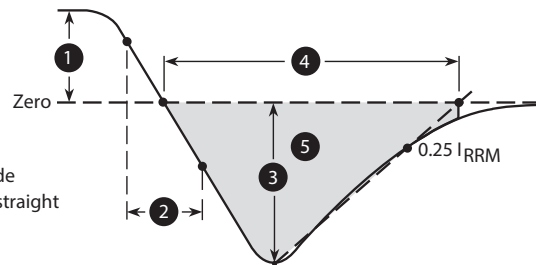


Figure 2-11. Diode Reverse Recovery Waveform and Definitions

- 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 $0.25 \cdot I_{RRM}$ passes through zero.
- 5 Q_{rr} — Area under the curve defined by I_{RRM} and t_{rr} .



.....continued		Dimensions (mm)		
Dimension Limits		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

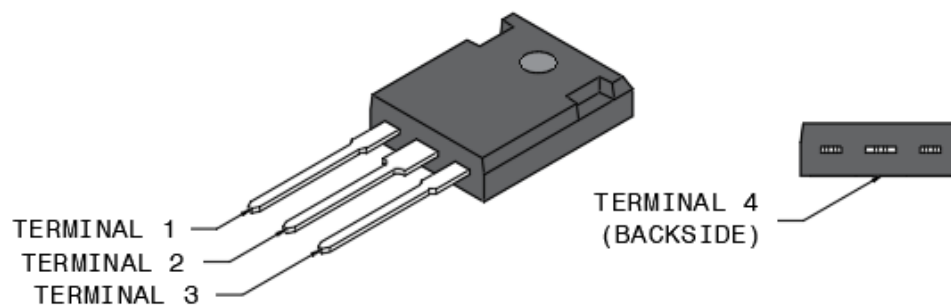
Notes: Dimensioning and tolerancing per ASME Y14.5M

- 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

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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PIS_TABLE - Variable missing PIS_EXAMPLE - Variable missing PIS_NOTES - Variable missing

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ISBN: 978-1-6683-0197-5

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