

High Speed PT IGBT


POWER MOS 8® is a high speed Punch-Through switch-mode IGBT. Low E_{off} is achieved through leading technology silicon design and lifetime control processes. A reduced $E_{off} - V_{CE(ON)}$ tradeoff results in superior efficiency compared to other IGBT technologies. Low gate charge and a greatly reduced ratio of C_{res}/C_{ies} provide excellent noise immunity, short delay times and simple gate drive. The intrinsic chip gate resistance and capacitance of the poly-silicone gate structure help control di/dt during switching, resulting in low EMI, even when switching at high frequency.


APT60GA60JD60

Combi (IGBT and Diode)



FEATURES

- Fast switching with low EMI
- Very Low E_{off} for maximum efficiency
- Ultra low C_{res} for improved noise immunity
- Low conduction loss
- Low gate charge
- Increased intrinsic gate resistance for low EMI
- RoHS compliant 

TYPICAL APPLICATIONS

- ZVS phase shifted and other full bridge
- Half bridge
- High power PFC boost
- Welding
- UPS, solar, and other inverters
- High frequency, high efficiency industrial

Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{ces}	Collector Emitter Voltage	600	V
I_{C1}	Continuous Collector Current @ $T_c = 25^\circ\text{C}$	112	A
I_{C2}	Continuous Collector Current @ $T_c = 100^\circ\text{C}$	60	
I_{CM}	Pulsed Collector Current ¹	178	
V_{GE}	Gate-Emitter Voltage ²	±30	V
P_D	Total Power Dissipation @ $T_c = 25^\circ\text{C}$	356	W
SSOA	Switching Safe Operating Area @ $T_j = 150^\circ\text{C}$	178A @ 600V	
T_j, T_{STG}	Operating and Storage Junction Temperature Range	-55 to 150	°C

Static Characteristics

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{BR(CEs)}$	Collector-Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 1.0mA$	600			V
$V_{CE(on)}$	Collector-Emitter On Voltage	$V_{GE} = 15V, I_C = 62A$		2.0 1.9	2.5	
		$T_j = 25^\circ\text{C}$ $T_j = 125^\circ\text{C}$				
$V_{GE(th)}$	Gate Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 1mA$	3	4.5	6	
I_{CES}	Zero Gate Voltage Collector Current	$V_{CE} = 600V, V_{GE} = 0V$			275 3000	μA
I_{GES}	Gate-Emitter Leakage Current	$V_{GS} = \pm 30V$			±100	nA

Dynamic Characteristics

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

APT60GA60JD60

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
C_{ies}	Input Capacitance	Capacitance $V_{GE} = 0V, V_{CE} = 25V$ $f = 1\text{MHz}$		8010		pF
C_{oes}	Output Capacitance			714		
C_{res}	Reverse Transfer Capacitance			74		
Q_g^3	Total Gate Charge	Gate Charge $V_{GE} = 15V$ $V_{CE} = 300V$ $I_C = 62A$		296		nC
Q_{ge}	Gate-Emitter Charge			106		
Q_{gc}	Gate-Collector Charge			60		
SSOA	Switching Safe Operating Area	$T_J = 150^\circ\text{C}, R_G = 4.7\Omega^4, V_{GE} = 15V,$ $L = 100\mu\text{H}, V_{CE} = 600V$	178			A
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (25°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 62A$ $R_G = 4.7\Omega^4$		35		ns
t_r	Current Rise Time			49		
$t_{d(off)}$	Turn-Off Delay Time			175		
t_f	Current Fall Time			91		
E_{on2}	Turn-On Switching Energy			1450		
E_{off}^6	Turn-Off Switching Energy	$T_J = +25^\circ\text{C}$		1255		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (125°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 62A$ $R_G = 4.7\Omega^4$		33		ns
t_r	Current Rise Time			49		
$t_{d(off)}$	Turn-Off Delay Time			214		
t_f	Current Fall Time			119		
E_{on2}	Turn-On Switching Energy			1995		
E_{off}^6	Turn-Off Switching Energy	$T_J = +125^\circ\text{C}$		1760		

Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction to Case Thermal Resistance (IGBT)	-	-	.35	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Junction to Case Thermal Resistance (Diode)			.60	
W_T	Package Weight	-	29.2	-	g
$V_{isolation}$	RMS Voltage (50-60Hz Sinusoidal Waveform from Terminals to Mounting Base for 1 Min.)	2500			Volts

1 Repetitive Rating: Pulse width and case temperature limited by maximum junction temperature.

2 Pulse test: Pulse Width $< 380\mu\text{s}$, duty cycle $< 2\%$.

3 See Mil-Std-750 Method 3471.

4 R_G is external gate resistance, not including internal gate resistance or gate driver impedance. (MIC4452)

5 E_{on2} is the clamped inductive turn on energy that includes a commutating diode reverse recovery current in the IGBT turn on energy loss. A combi device is used for the clamping diode.

6 E_{off} is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1.

Microsemi reserves the right to change, without notice, the specifications and information contained herein.

Typical Performance Curves

APT60GA60JD60

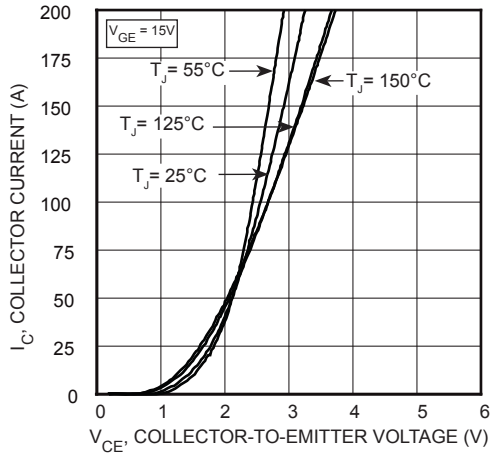


FIGURE 1, Output Characteristics ($T_J = 25^\circ\text{C}$)

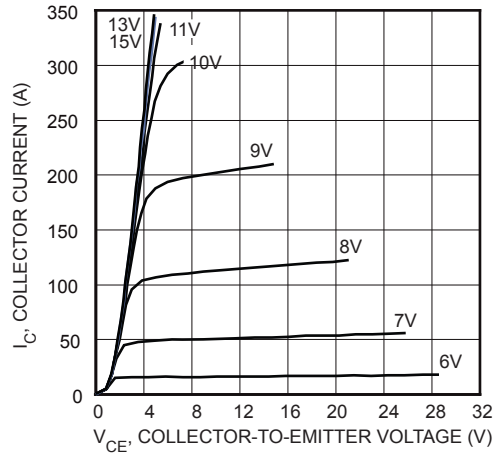


FIGURE 2, Output Characteristics ($T_J = 25^\circ\text{C}$)

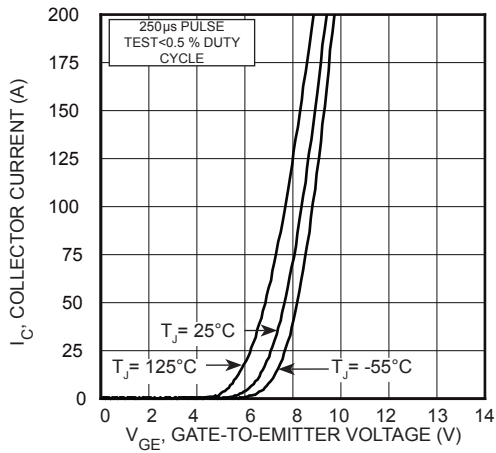


FIGURE 3, Transfer Characteristics

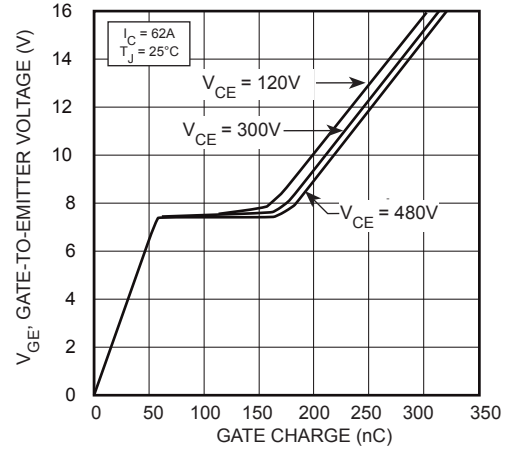


FIGURE 4, Gate charge

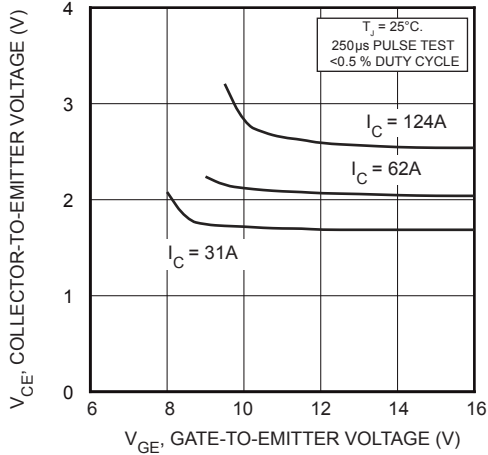


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

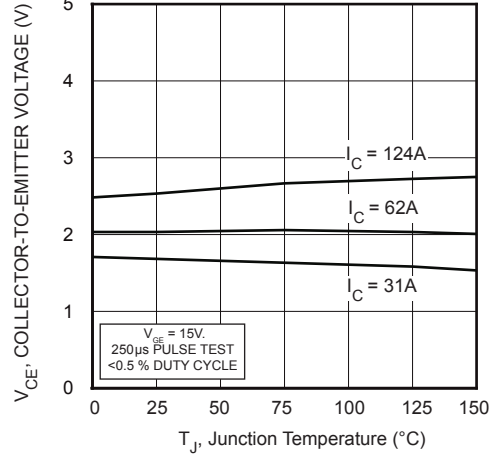


FIGURE 6, On State Voltage vs Junction Temperature

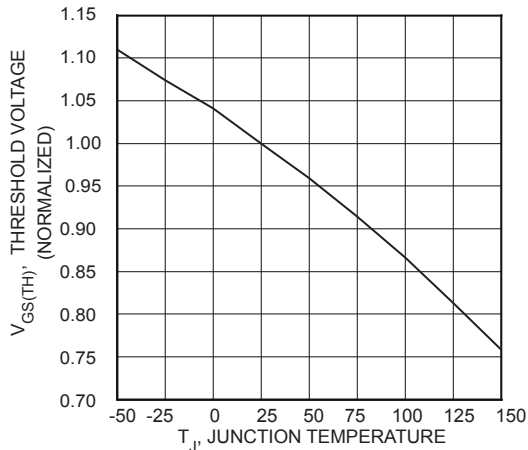


FIGURE 7, Threshold Voltage vs Junction Temperature

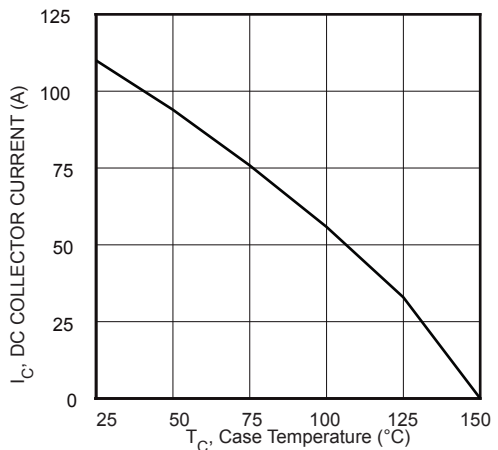


FIGURE 8, DC Collector Current vs Case Temperature

Typical Performance Curves

APT60GA60JD60

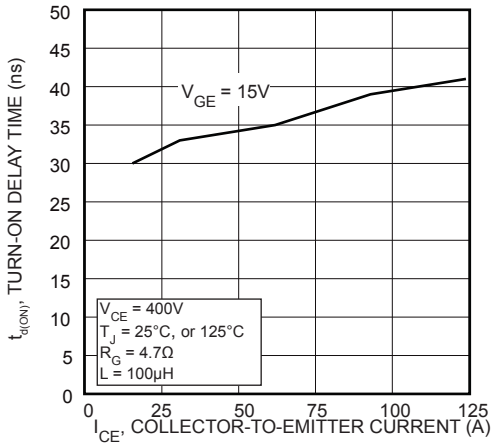


FIGURE 9, Turn-On Delay Time vs Collector Current

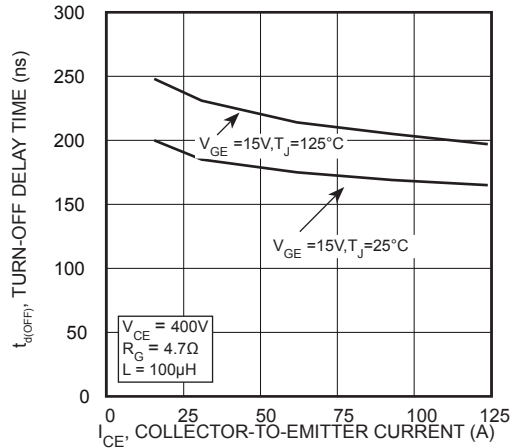


FIGURE 10, Turn-Off Delay Time vs Collector Current

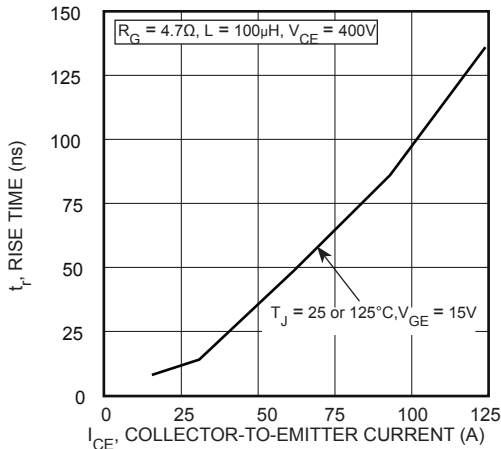


FIGURE 11, Current Rise Time vs Collector Current

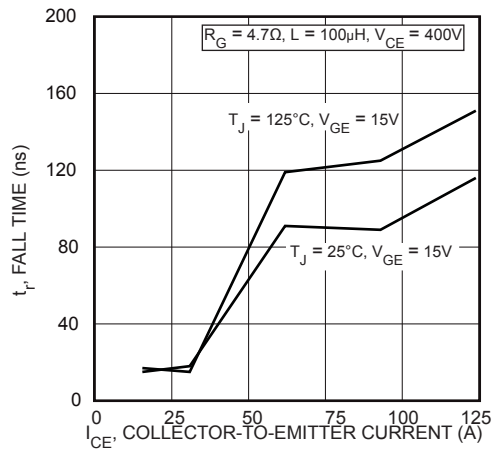


FIGURE 12, Current Fall Time vs Collector Current

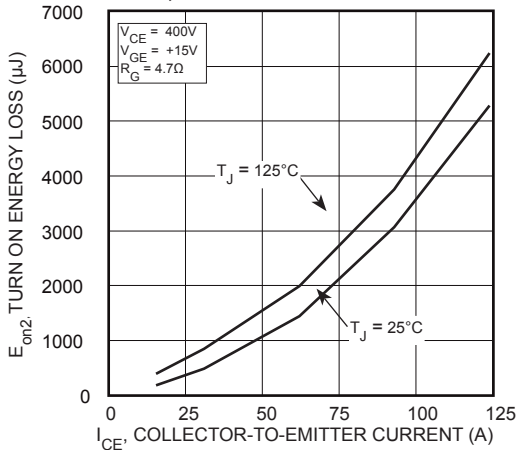


FIGURE 13, Turn-On Energy Loss vs Collector Current

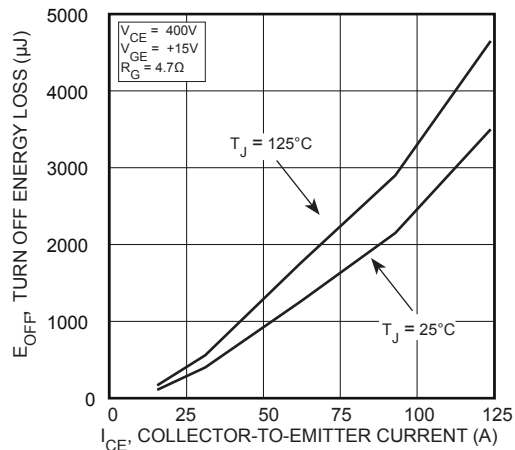


FIGURE 14, Turn-Off Energy Loss vs Collector Current

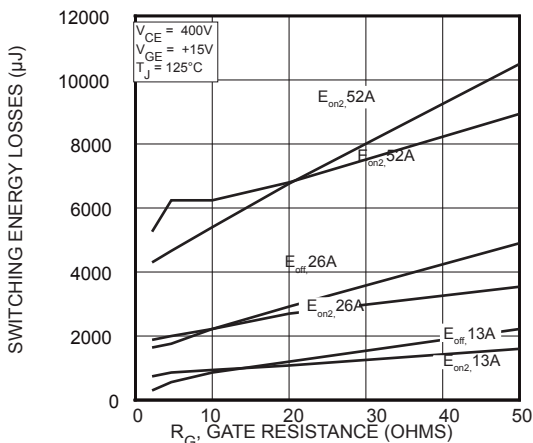


FIGURE 15, Switching Energy Losses vs Gate Resistance

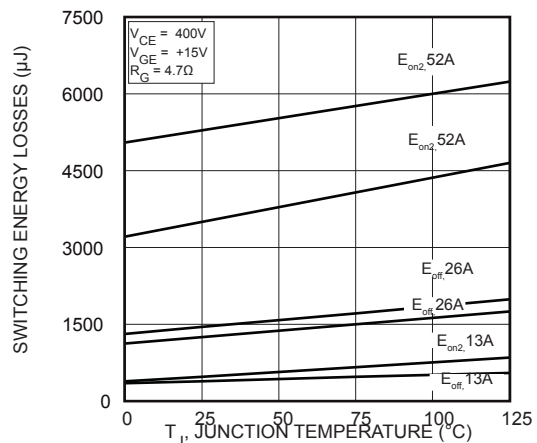


FIGURE 16, Switching Energy Losses vs Junction Temperature

Typical Performance Curves

APT60GA60JD60

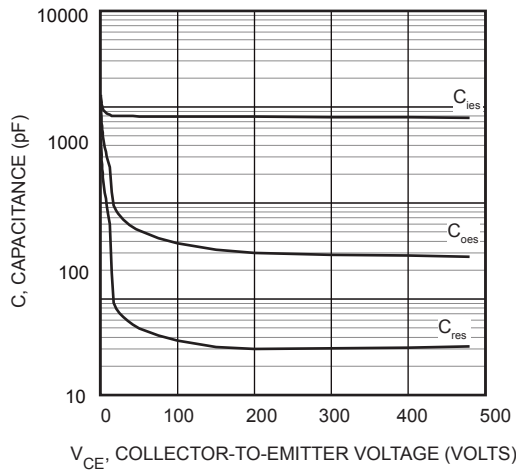


FIGURE 17, Capacitance vs Collector-To-Emitter Voltage

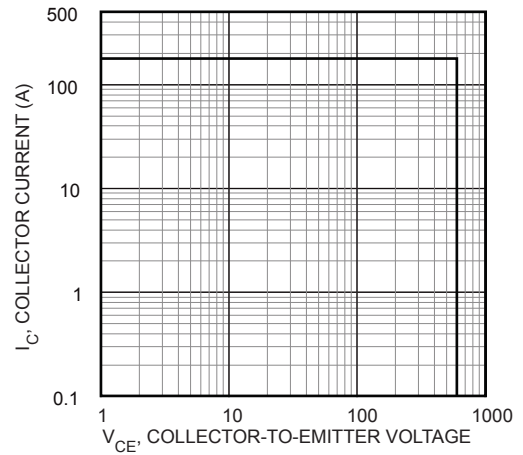


FIGURE 18, Minimum Switching Safe Operating Area

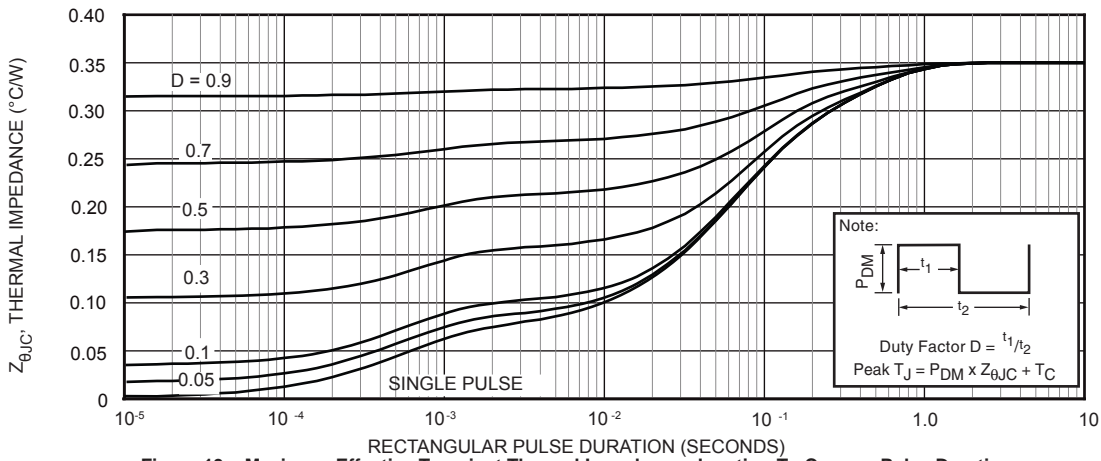


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

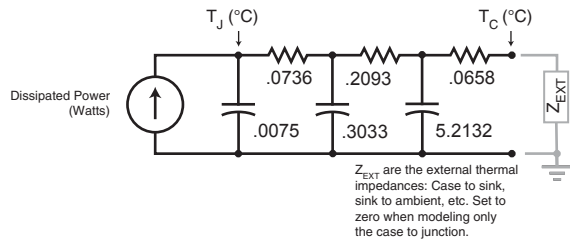


FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL

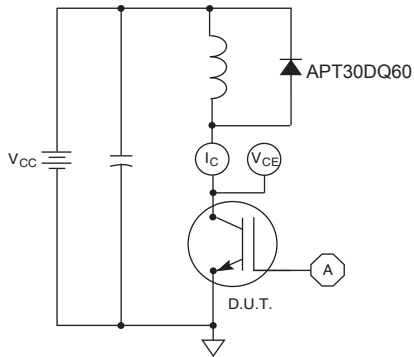


Figure 20, Inductive Switching Test Circuit

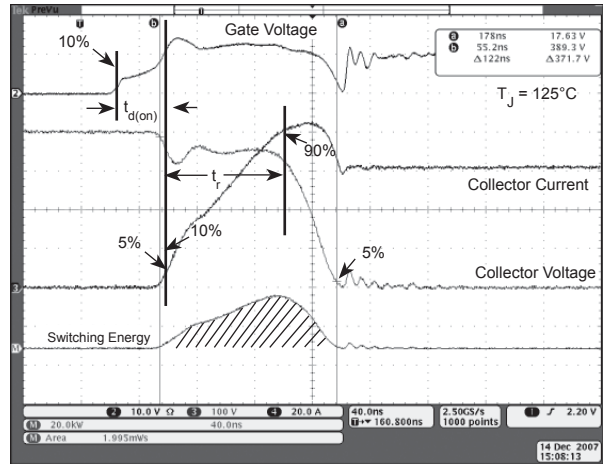


Figure 21, Turn-on Switching Waveforms and Definitions

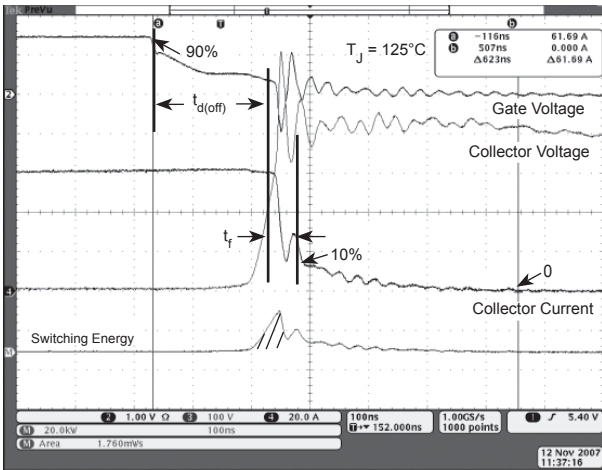


Figure 22, Turn-off Switching Waveforms and Definitions

ULTRAFAST SOFT RECOVERY RECTIFIER DIODE

MAXIMUM RATINGS

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

Symbol	Characteristic / Test Conditions	APT60GA60JD60	Unit
$I_{F(AV)}$	Maximum Average Forward Current ($T_C = 92^\circ\text{C}$, Duty Cycle = 0.5)	60	Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)	79	
I_{FSM}	Non-Repetitive Forward Surge Current ($T_J = 45^\circ\text{C}$, 8.3 ms)	600	

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	Min	Type	Max	Unit
V_F	Forward Voltage	$I_F = 60\text{A}$		1.7	Volts
		$I_F = 120\text{A}$		2.0	
		$I_F = 60\text{A}, T_J = 125^\circ\text{C}$		1.4	

DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
t_{rr}	Reverse Recovery Time	$I_F = 1\text{A}, di_F/dt = -100\text{A}/\mu\text{s}, V_R = 30\text{V}, T_J = 25^\circ\text{C}$	-	160	-	ns
t_{rr}	Reverse Recovery Time	$I_F = 60\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 25^\circ\text{C}$	-	70	-	ns
Q_{rr}	Reverse Recovery Charge		-	100	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps
t_{rr}	Reverse Recovery Time	$I_F = 60\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	140	-	ns
Q_{rr}	Reverse Recovery Charge		-	690	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	9	-	Amps
t_{rr}	Reverse Recovery Time	$I_F = 60\text{A}, di_F/dt = -1000\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	80	-	ns
Q_{rr}	Reverse Recovery Charge		-	1540	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	31	-	Amps

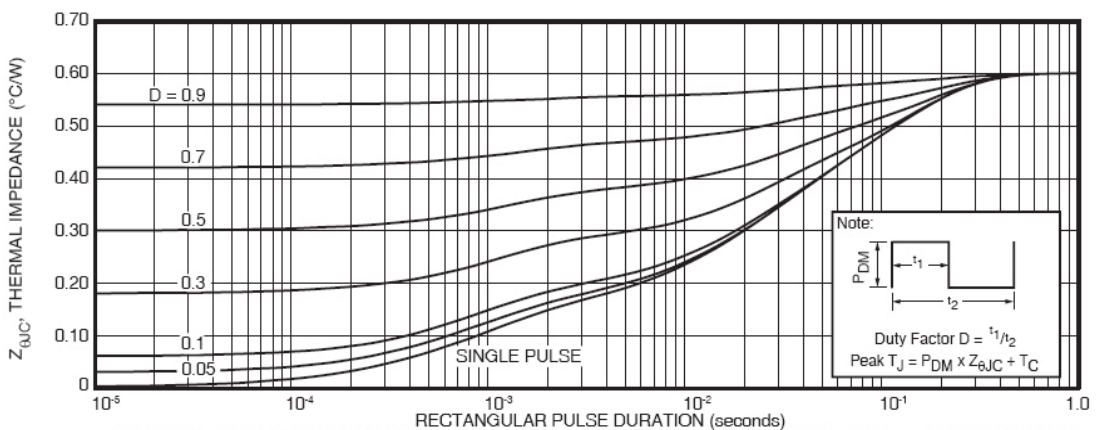
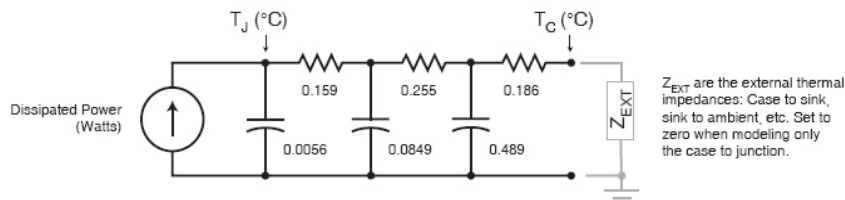


FIGURE 1a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION



Z_{EXT} are the external thermal impedances: Case to sink, sink to ambient, etc. Set to zero when modeling only the case to junction.

FIGURE 1b. TRANSIENT THERMAL IMPEDANCE MODEL

Dynamic Characteristics

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

APT60GA60JD60

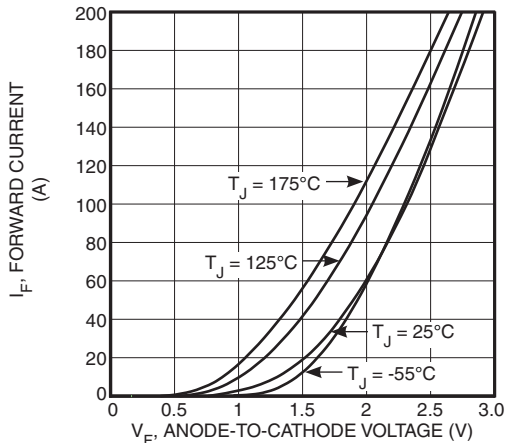


Figure 2. Forward Current vs. Forward Voltage

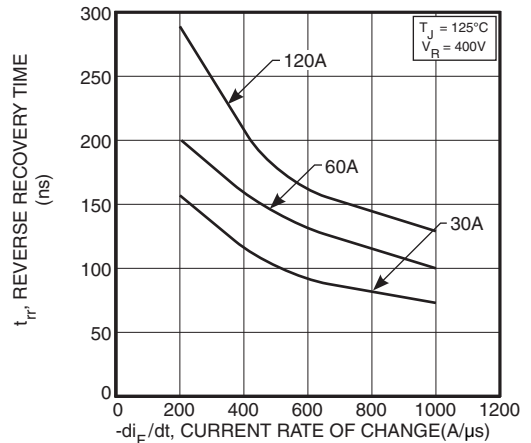


Figure 3. Reverse Recovery Time vs. Current Rate of Change

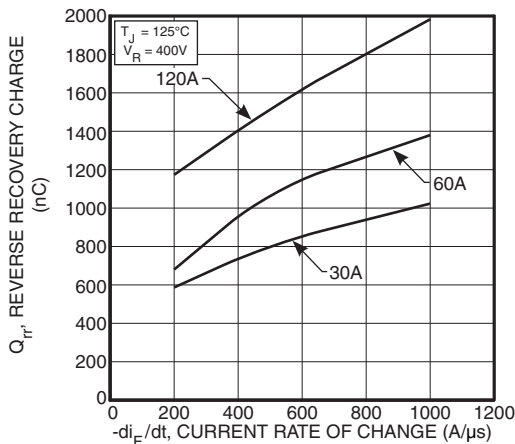


Figure 4. Reverse Recovery Charge vs. Current Rate of Change

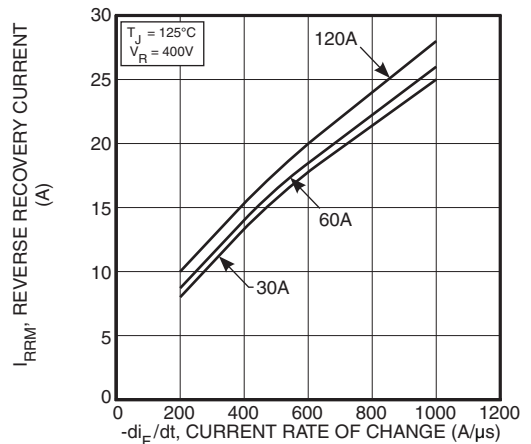


Figure 5. Reverse Recovery Current vs. Current Rate of Change

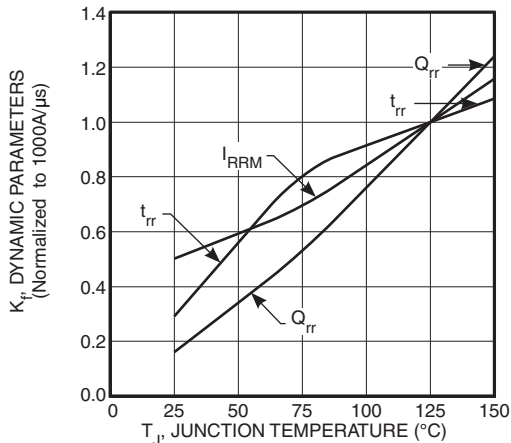


Figure 6. Dynamic Parameters vs. Junction Temperature

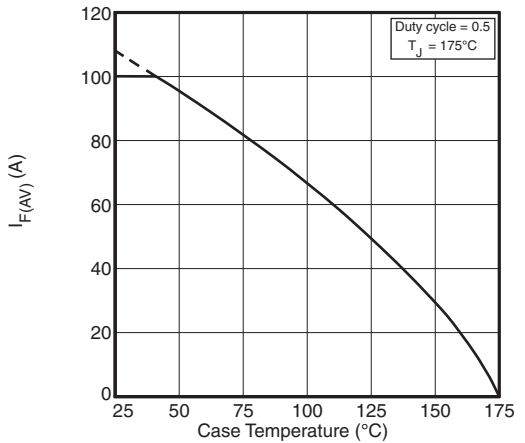


Figure 7. Maximum Average Forward Current vs. Case Temperature

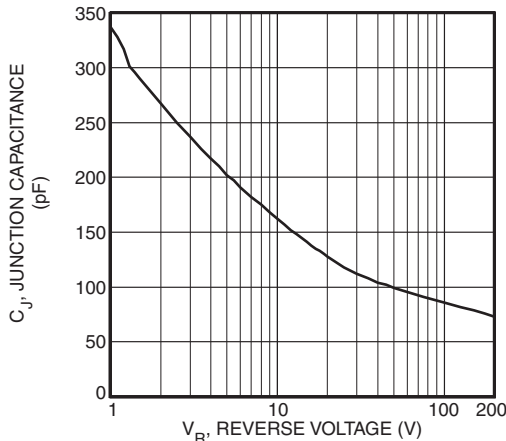


Figure 8. Junction Capacitance vs. Reverse Voltage

Dynamic Characteristics

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

APT60GA60JD60

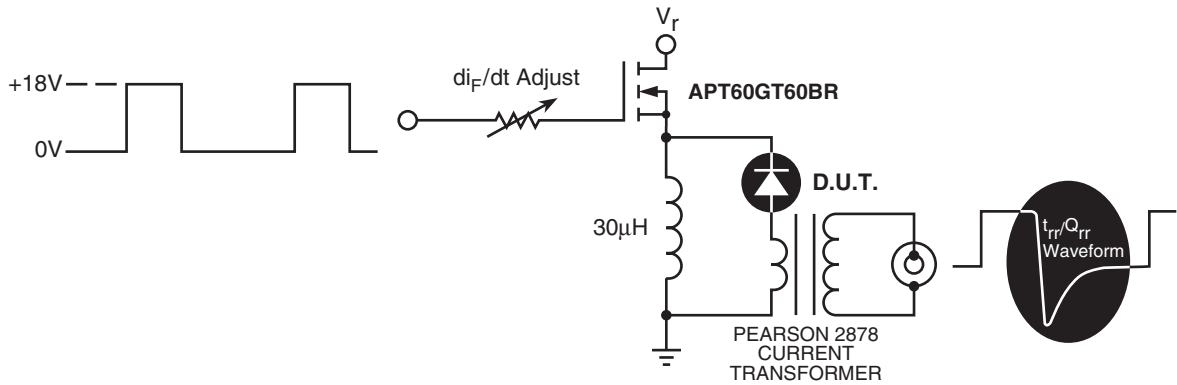


Figure 33. Diode Test Circuit

- 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} .

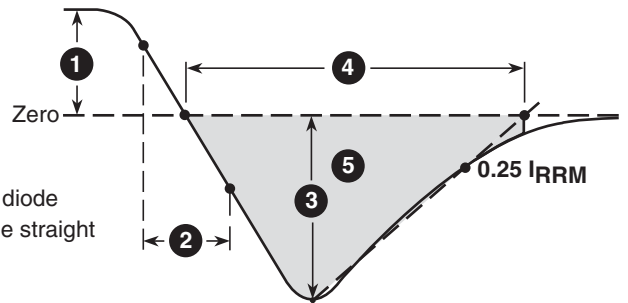
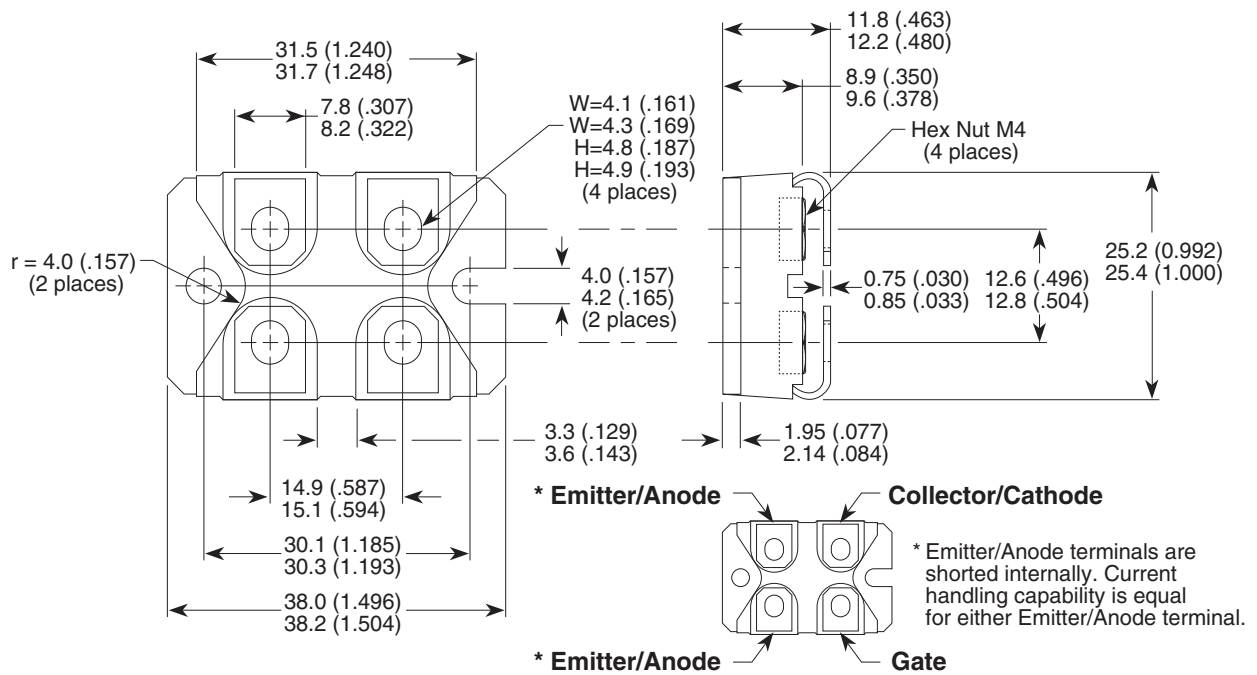


Figure 34. Diode Reverse Recovery Waveform and Definitions

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches)

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