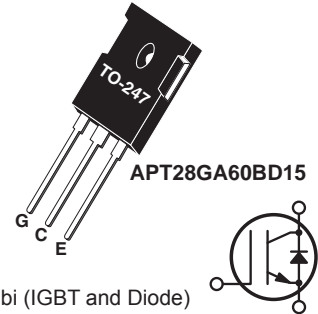



## High Speed PT IGBT

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.



### 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 @ $T_C = 25^\circ\text{C}$	50	A
$I_{C2}$	Continuous Collector Current @ $T_C = 100^\circ\text{C}$	28	
$I_{CM}$	Pulsed Collector Current <sup>1</sup>	84	
$V_{GE}$	Gate-Emitter Voltage <sup>2</sup>	$\pm 30$	V
$P_D$	Total Power Dissipation @ $T_C = 25^\circ\text{C}$	222	W
SSOA	Switching Safe Operating Area @ $T_J = 150^\circ\text{C}$	84A @ 600V	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to 150	°C
$T_L$	Lead Temperature for Soldering: 0.063" from Case for 10 Seconds	300	

### 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	$V_{GE} = 15V, I_C = 16A$ $T_J = 25^\circ\text{C}$ $T_J = 125^\circ\text{C}$		2.0 1.9	2.5	
$V_{GE(th)}$	Gate Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 1mA$	3	4.5	6	
$I_{CES}$	Zero Gate Voltage Collector Current	$V_{CE} = 600V, V_{GE} = 0V$ $T_J = 25^\circ\text{C}$ $T_J = 125^\circ\text{C}$			275 3000	$\mu\text{A}$
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GS} = \pm 30V$			$\pm 100$	nA

## Dynamic Characteristics

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

APT28GA60BD15

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$C_{ies}$	Input Capacitance	Capacitance $V_{GE} = 0V, V_{CE} = 25V$ $f = 1\text{MHz}$		2109		pF
$C_{oes}$	Output Capacitance			214		
$C_{res}$	Reverse Transfer Capacitance			26		
$Q_g^3$	Total Gate Charge	Gate Charge $V_{GE} = 15V$ $V_{CE} = 300V$ $I_C = 16A$		90		nC
$Q_{ge}$	Gate-Emitter Charge			14		
$Q_{gc}$	Gate-Collector Charge			28		
SSOA	Switching Safe Operating Area	$T_J = 150^\circ\text{C}, R_G = 10\Omega^4, V_{GE} = 15V,$ $L = 100\mu\text{H}, V_{CE} = 600V$	84			A
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching ( $25^\circ\text{C}$ ) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 16A$ $R_G = 10\Omega^4$ $T_J = +25^\circ\text{C}$		11		ns
$t_r$	Current Rise Time			8		
$t_{d(off)}$	Turn-Off Delay Time			101		
$t_f$	Current Fall Time			27		
$E_{on2}$	Turn-On Switching Energy			239		
$E_{off}^6$	Turn-Off Switching Energy		170		$\mu\text{J}$	
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching ( $125^\circ\text{C}$ ) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 16A$ $R_G = 10\Omega^4$ $T_J = +125^\circ\text{C}$		11		ns
$t_r$	Current Rise Time			10		
$t_{d(off)}$	Turn-Off Delay Time			132		
$t_f$	Current Fall Time			114		
$E_{on2}$	Turn-On Switching Energy			412		
$E_{off}^6$	Turn-Off Switching Energy		335		$\mu\text{J}$	

## Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction to Case Thermal Resistance (IGBT)	-	-	.56	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Junction to Case Thermal Resistance (Diode)			1.35	
$W_T$	Package Weight	-	5.9	-	g
Torque	Mounting Torque (TO-247 Package), 4-40 or M3 screw			10	in-lbf

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

APT28GA60BD15

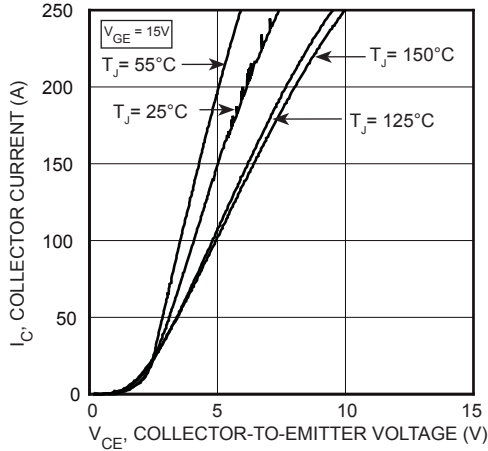


FIGURE 1, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

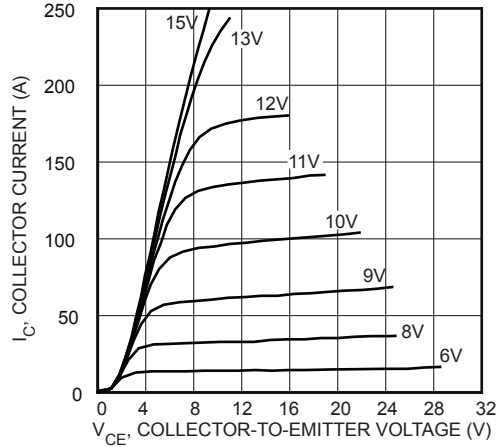


FIGURE 2, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

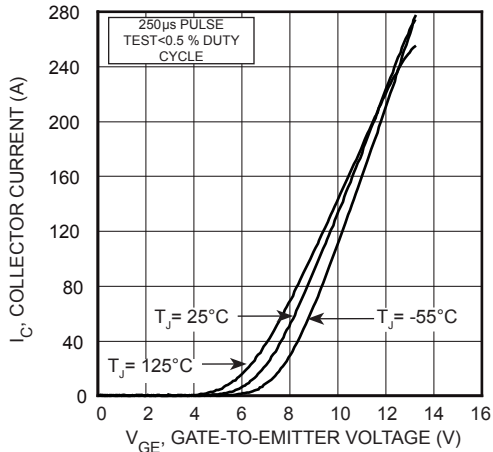


FIGURE 3, Transfer Characteristics

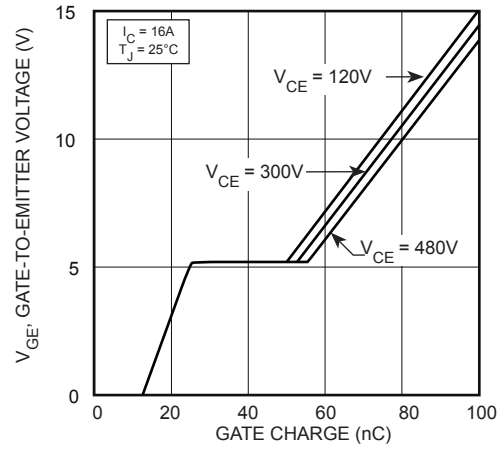


FIGURE 4, Gate charge

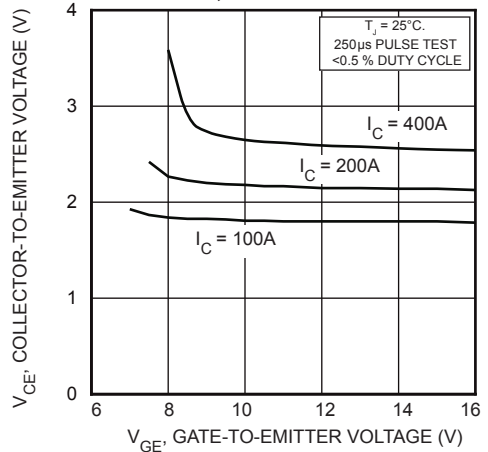


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

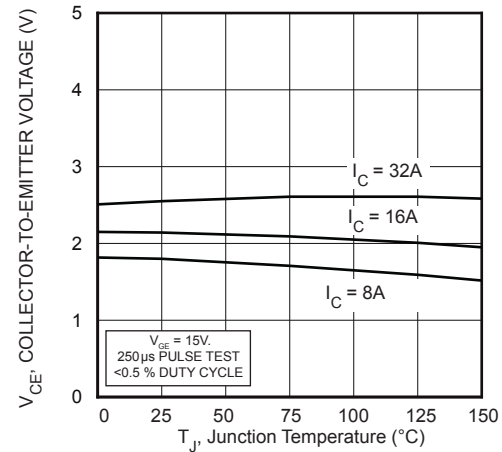


FIGURE 6, On State Voltage vs Junction Temperature

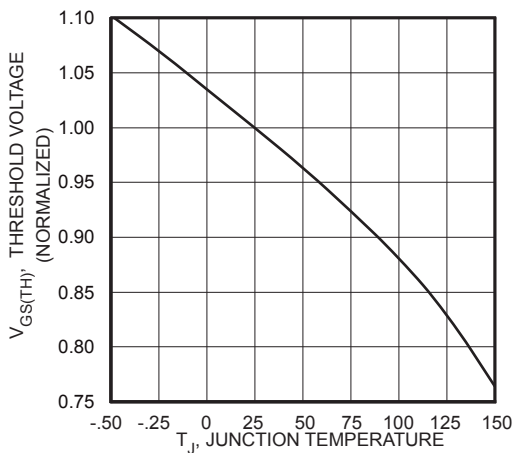


FIGURE 7, Threshold Voltage vs Junction Temperature

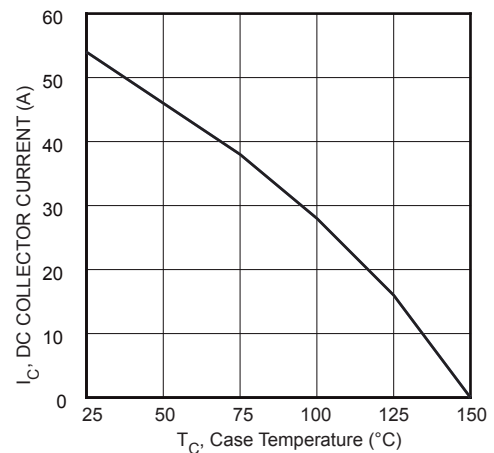


FIGURE 8, DC Collector Current vs Case Temperature

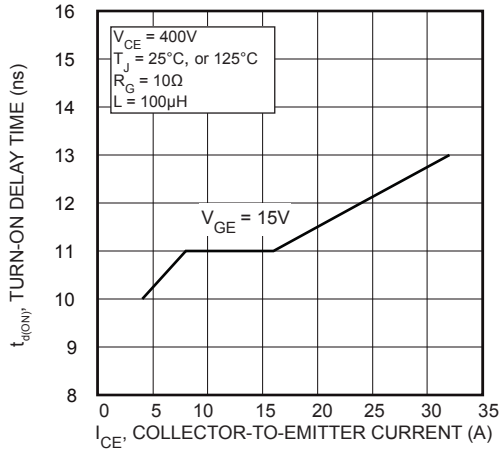


FIGURE 9, Turn-On Delay Time vs Collector Current

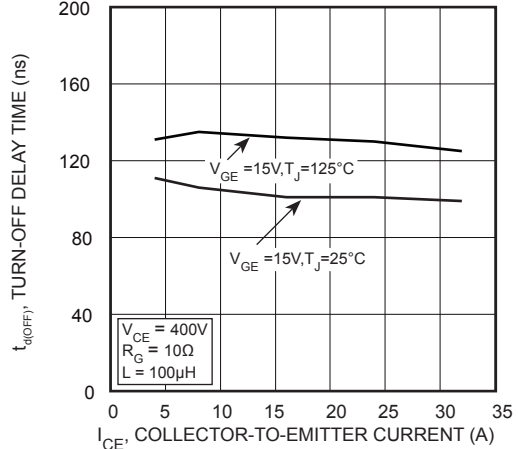


FIGURE 10, Turn-Off Delay Time vs Collector Current

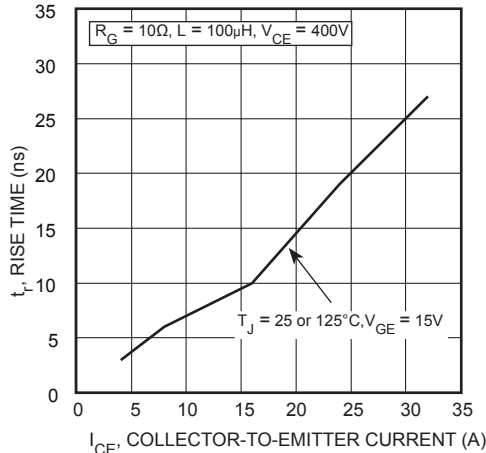


FIGURE 11, Current Rise Time vs Collector Current

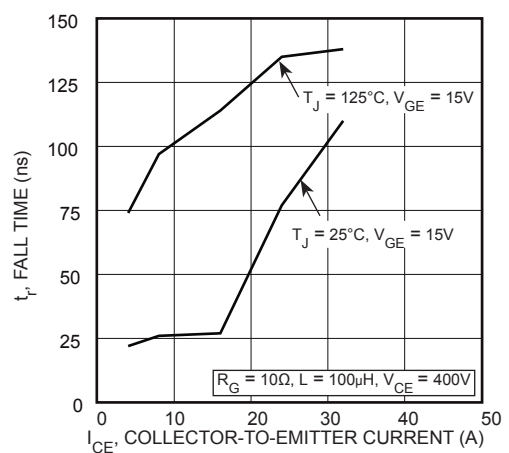


FIGURE 12, Current Fall Time vs Collector Current

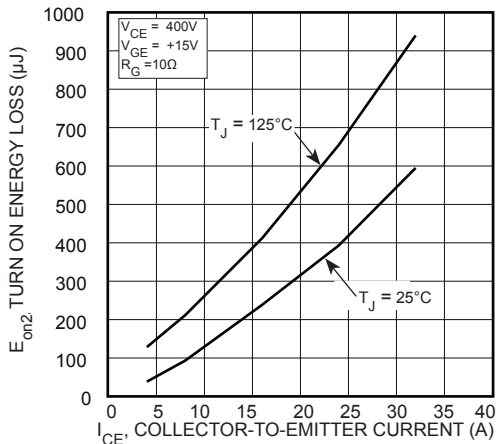


FIGURE 13, Turn-On Energy Loss vs Collector Current

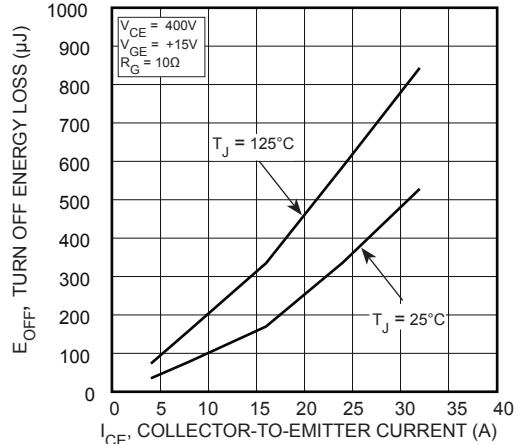


FIGURE 14, Turn-Off Energy Loss vs Collector Current

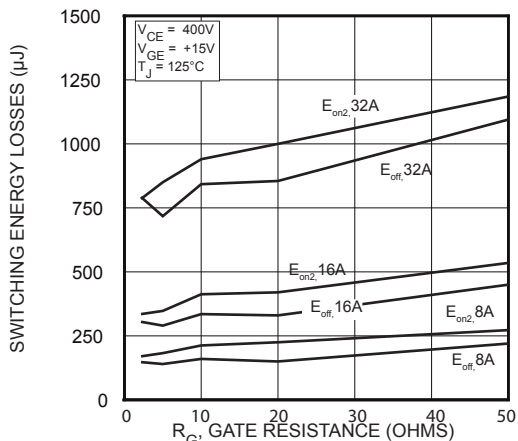


FIGURE 15, Switching Energy Losses vs Gate Resistance

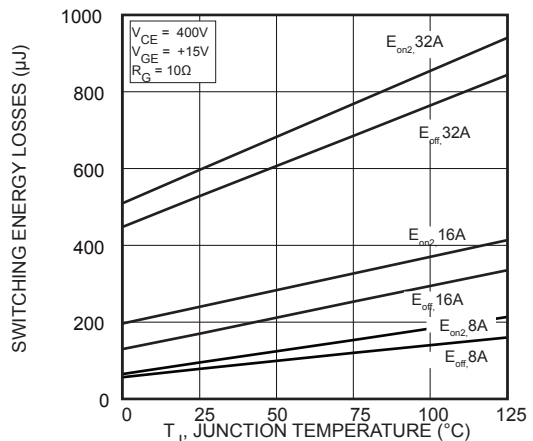


FIGURE 16, Switching Energy Losses vs Junction Temperature

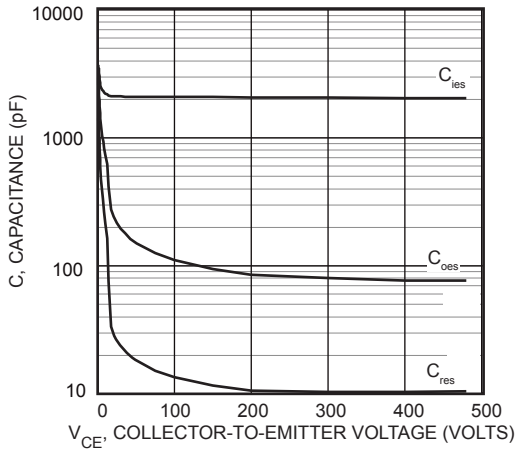


FIGURE 17, Capacitance vs Collector-To-Emitter Voltage

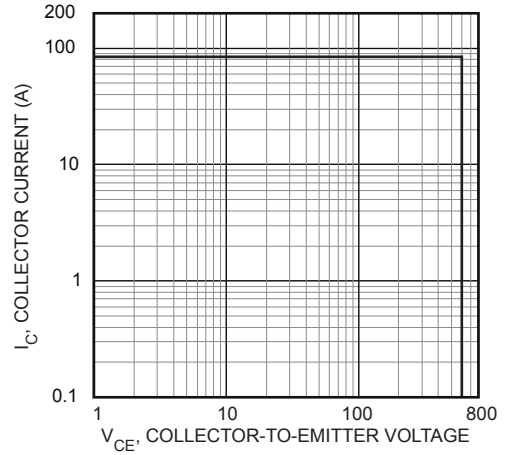


FIGURE 18, Minimum Switching Safe Operating Area

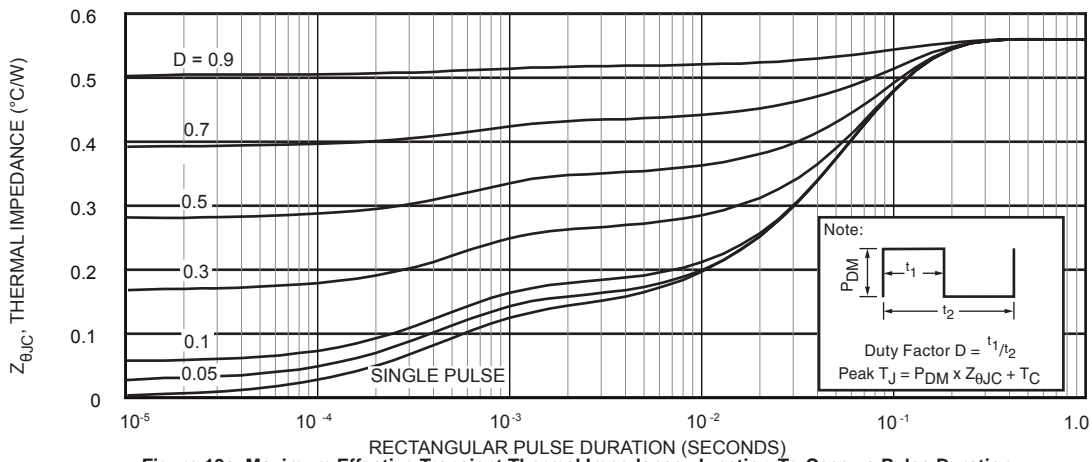


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

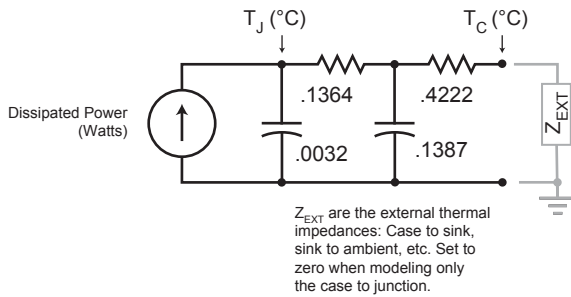


FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL

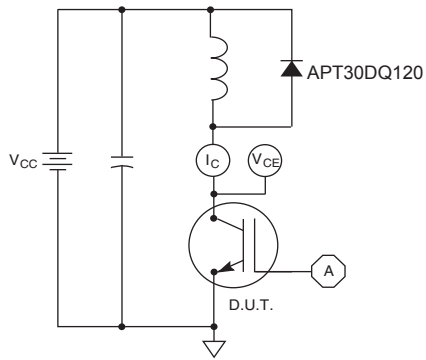


Figure 12, Inductive Switching Test Circuit

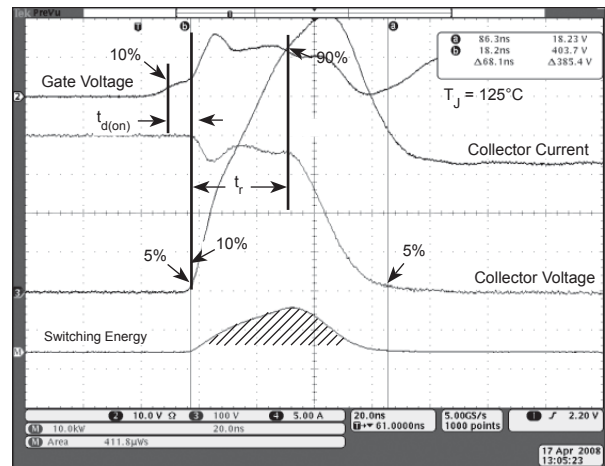


Figure 13, Turn-on Switching Waveforms and Definitions

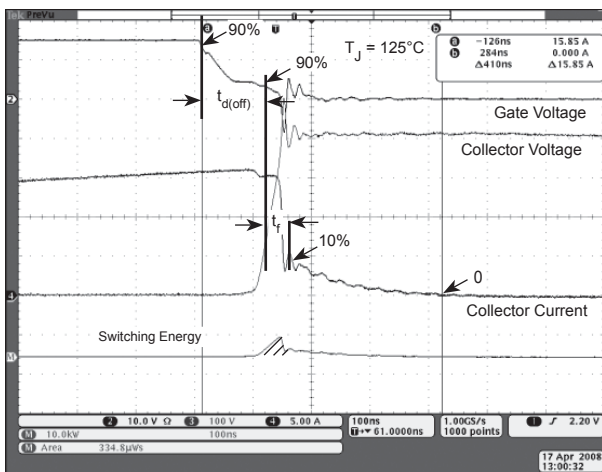


Figure 14, Turn-off Switching Waveforms and Definitions

# ULTRAFAST SOFT RECOVERY RECTIFIER DIODE

## MAXIMUM RATINGS

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

Symbol	Characteristic / Test Conditions	APT28GA60BD15	Unit
$I_{F(AV)}$	Maximum Average Forward Current ( $T_C = 129^\circ\text{C}$ , Duty Cycle = 0.5)	600	Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)	30	
$I_{FSM}$	Non-Repetitive Forward Surge Current ( $T_J = 45^\circ\text{C}$ , 8.3 ms)	110	

## STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	Min	Type	Max	Unit
$V_F$	Forward Voltage		$I_F = 15\text{A}$	2.0	Volts
			$I_F = 30\text{A}$	2.5	
			$I_F = 15\text{A}, T_J = 125^\circ\text{C}$	1.56	

## DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$t_{rr}$	Reverse Recovery Time	$I_F = 1\text{A}, di_F/dt = -100\text{A}/\mu\text{s}, V_R = 30\text{V}, T_J = 25^\circ\text{C}$	-	15	-	ns
$t_{rr}$	Reverse Recovery Time	$I_F = 15\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 25^\circ\text{C}$	-	19	-	ns
$Q_{rr}$	Reverse Recovery Charge		-	21	-	
$I_{RRM}$	Maximum Reverse Recovery Current	$I_F = 15\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	2	-	Amps
$t_{rr}$	Reverse Recovery Time		-	105	-	ns
$Q_{rr}$	Reverse Recovery Charge	$I_F = 15\text{A}, di_F/dt = -1000\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	250	-	nC
$I_{RRM}$	Maximum Reverse Recovery Current		-	5	-	Amps
$t_{rr}$	Reverse Recovery Time	$I_F = 15\text{A}, di_F/dt = -1000\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	55	-	ns
$Q_{rr}$	Reverse Recovery Charge		-	420	-	nC
$I_{RRM}$	Maximum Reverse Recovery Current		-	15	-	Amps

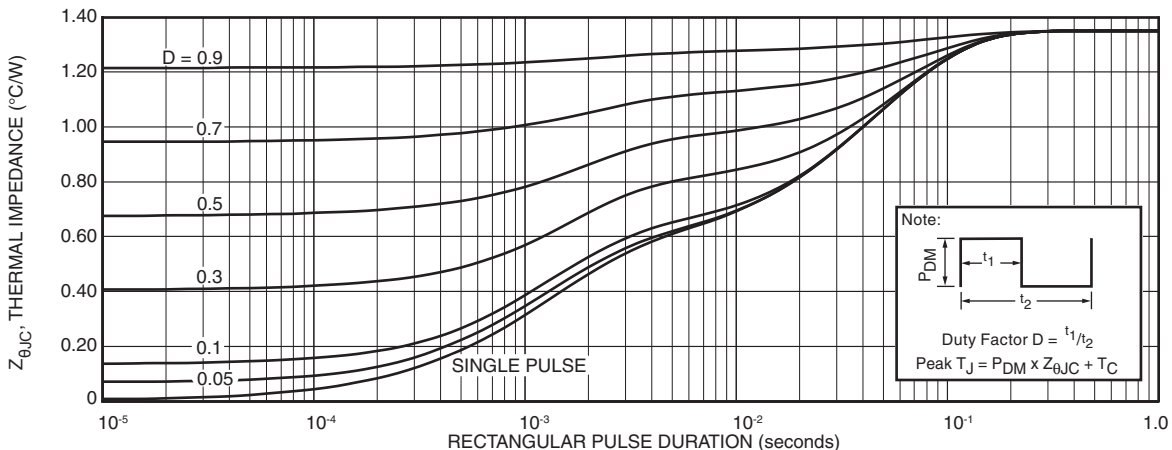


FIGURE 1a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

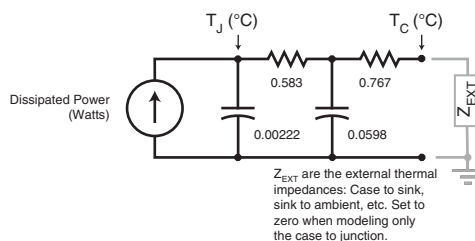


FIGURE 1b. TRANSIENT THERMAL IMPEDANCE MODEL

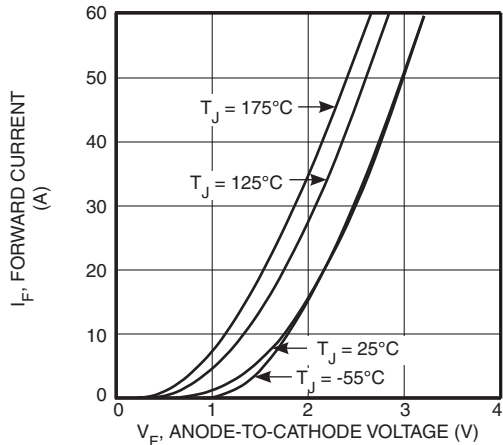


Figure 2. Forward Current vs. Forward Voltage

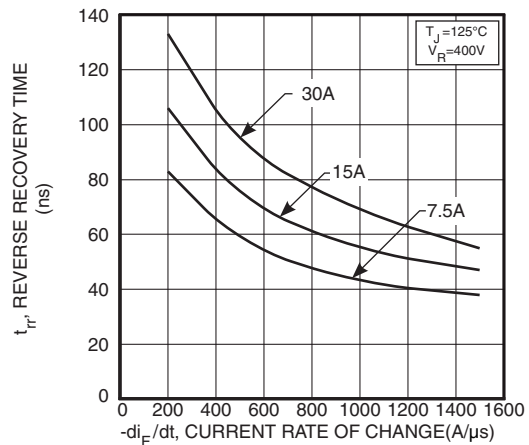


Figure 3. Reverse Recovery Time vs. Current Rate of Change

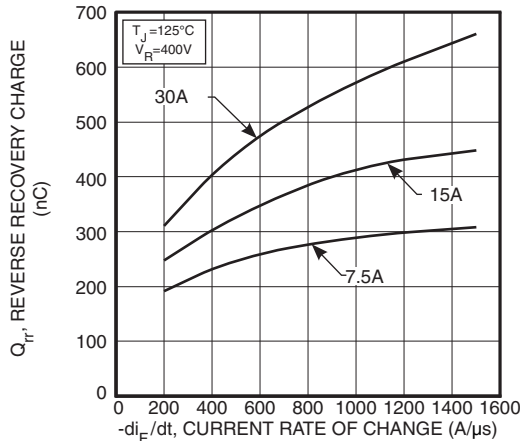


Figure 4. Reverse Recovery Charge vs. Current Rate of Change

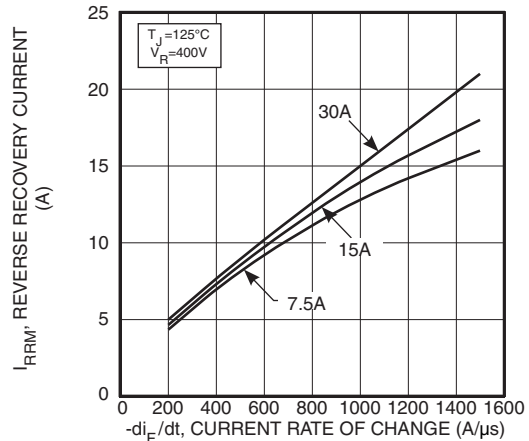


Figure 5. Reverse Recovery Current vs. Current Rate of Change

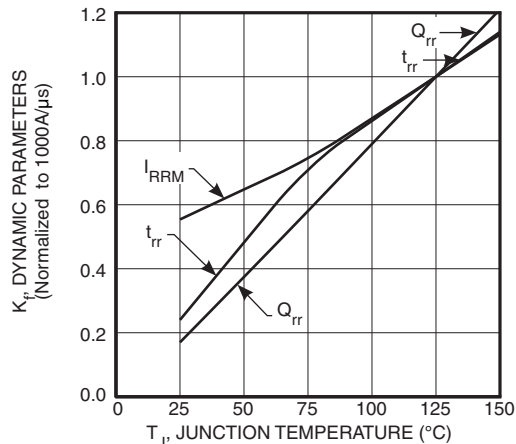


Figure 6. Dynamic Parameters vs. Junction Temperature

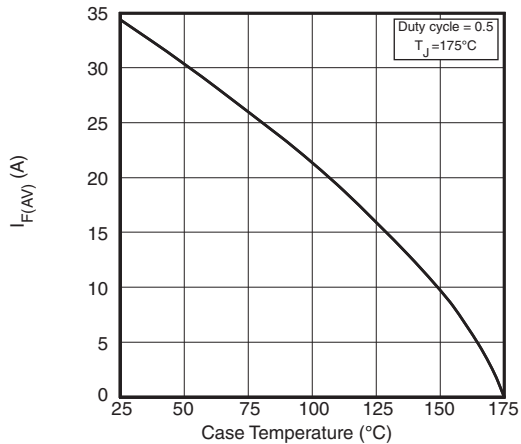


Figure 7. Maximum Average Forward Current vs. Case Temperature

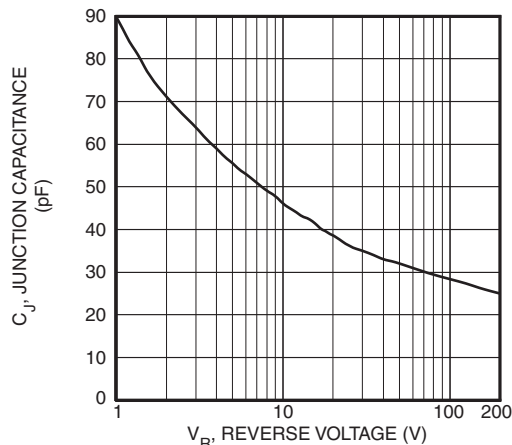


Figure 8. Junction Capacitance vs. Reverse Voltage



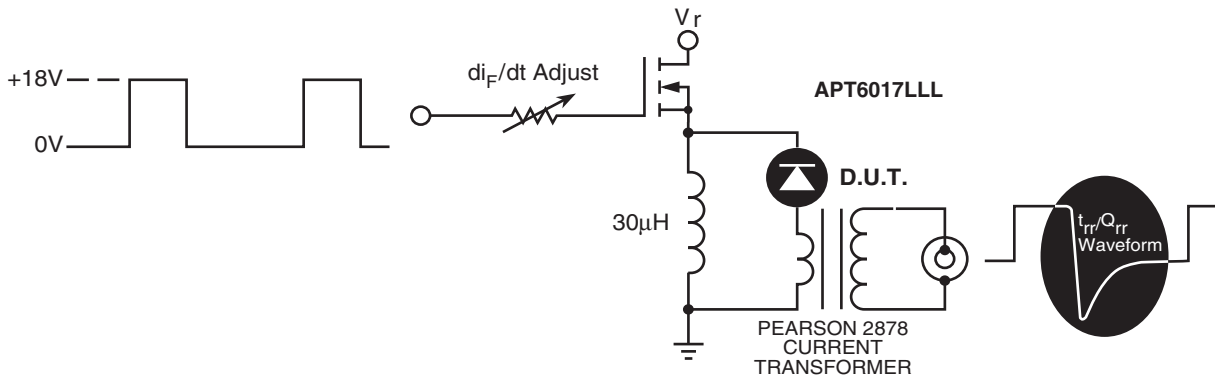


Figure 9. Diode Test Circuit

- 1 I<sub>F</sub> - Forward Conduction Current
- 2 di<sub>F</sub>/dt - Rate of Diode Current Change Through Zero Crossing.
- 3 I<sub>RRM</sub> - Maximum Reverse Recovery Current.
- 4 t<sub>rr</sub> - 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<sub>RRM</sub> and 0.25•I<sub>RRM</sub> passes through zero.
- 5 Q<sub>rr</sub> - Area Under the Curve Defined by I<sub>RRM</sub> and t<sub>rr</sub>.

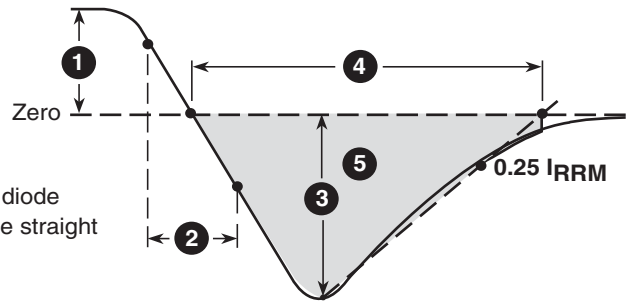
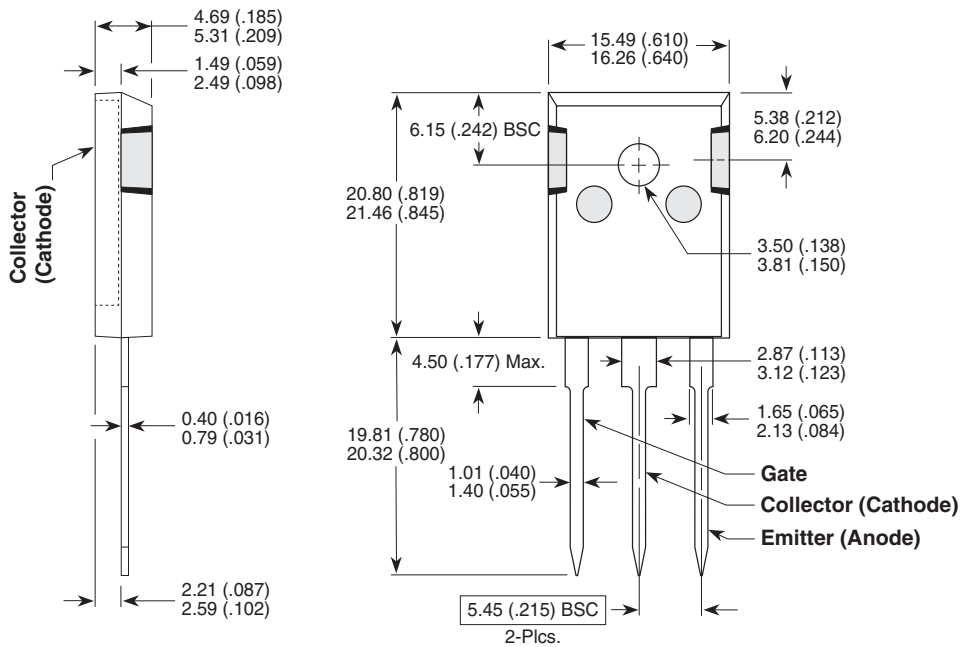


Figure 10, Diode Reverse Recovery Waveform and Definitions

TO-247 (B) Package Outline



Dimensions in Millimeters and (Inches)