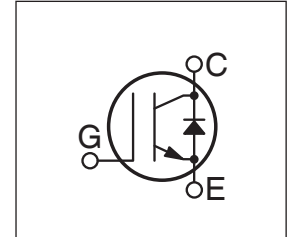


POWER MOS 7® IGBT

The POWER MOS 7® IGBT is a new generation of high voltage power IGBTs. Using Punch Through Technology this IGBT is ideal for many high frequency, high voltage switching applications and has been optimized for high frequency switchmode power supplies.

- Low Conduction Loss
- Low Gate Charge
- Ultrafast Tail Current shutoff
- 100 kHz operation @ 400V, 25A
- 200 kHz operation @ 400V, 16A
- SSOA Rated



MAXIMUM RATINGS

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

Symbol	Parameter	APT40GP60JDQ2	UNIT
V_{CES}	Collector-Emitter Voltage	600	Volts
V_{GE}	Gate-Emitter Voltage	± 30	
I_{C1}	Continuous Collector Current @ $T_C = 25^\circ\text{C}$	86	Amps
I_{C2}	Continuous Collector Current @ $T_C = 110^\circ\text{C}$	40	
I_{CM}	Pulsed Collector Current ^① @ $T_C = 150^\circ\text{C}$	160	
SSOA	Switching Safe Operating Area @ $T_J = 150^\circ\text{C}$	160A @ 600V	
P_D	Total Power Dissipation	284	Watts
T_J, T_{STG}	Operating and Storage Junction Temperature Range	-55 to 150	$^\circ\text{C}$
T_L	Max. Lead Temp. for Soldering: 0.063" from Case for 10 Sec.	300	

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	MIN	TYP	MAX	Units
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage ($V_{GE} = 0\text{V}, I_C = 250\mu\text{A}$)	600			Volts
$V_{GE(TH)}$	Gate Threshold Voltage ($V_{CE} = V_{GE}, I_C = 1\text{mA}, T_J = 25^\circ\text{C}$)	3	4.5	6	
$V_{CE(ON)}$	Collector-Emitter On Voltage ($V_{GE} = 15\text{V}, I_C = 40\text{A}, T_J = 25^\circ\text{C}$)		2.2	2.7	
	Collector-Emitter On Voltage ($V_{GE} = 15\text{V}, I_C = 40\text{A}, T_J = 125^\circ\text{C}$)		2.1		
I_{CES}	Collector Cut-off Current ($V_{CE} = 600\text{V}, V_{GE} = 0\text{V}, T_J = 25^\circ\text{C}$) ^②			500	μA
	Collector Cut-off Current ($V_{CE} = 600\text{V}, V_{GE} = 0\text{V}, T_J = 125^\circ\text{C}$) ^②			3000	
I_{GES}	Gate-Emitter Leakage Current ($V_{GE} = \pm 20\text{V}$)			± 100	nA

 **CAUTION:** These Devices are Sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.

DYNAMIC CHARACTERISTICS

APT40GP60JDQ2

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	Capacitance $V_{GE} = 0V, V_{CE} = 25V$ $f = 1 \text{ MHz}$		4610		pF
C_{oes}	Output Capacitance			395		
C_{res}	Reverse Transfer Capacitance			25		
V_{GEP}	Gate-to-Emitter Plateau Voltage	Gate Charge		7.5		V
Q_g	Total Gate Charge ⁽³⁾	$V_{GE} = 15V$		135		nC
Q_{ge}	Gate-Emitter Charge	$V_{CE} = 300V$		30		
Q_{gc}	Gate-Collector ("Miller") Charge	$I_C = 40A$		40		
SSOA	Switching Safe Operating Area	$T_J = 150^\circ C, R_G = 5\Omega, V_{GE} = 15V, L = 100\mu H, V_{CE} = 600V$	160			A
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 40A$ $R_G = 5\Omega$ $T_J = +25^\circ C$		20		ns
t_r	Current Rise Time			29		
$t_{d(off)}$	Turn-off Delay Time			64		
t_f	Current Fall Time			45		μJ
E_{on1}	Turn-on Switching Energy ⁽⁴⁾			385		
E_{on2}	Turn-on Switching Energy (Diode) ⁽⁵⁾			645		
E_{off}	Turn-off Switching Energy ⁽⁶⁾		350	450		
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (125°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 40A$ $R_G = 5\Omega$ $T_J = +125^\circ C$		20		ns
t_r	Current Rise Time			29		
$t_{d(off)}$	Turn-off Delay Time			90		
t_f	Current Fall Time			70		μJ
E_{on1}	Turn-on Switching Energy ⁽⁴⁾			385		
E_{on2}	Turn-on Switching Energy (Diode) ⁽⁵⁾			970		
E_{off}	Turn-off Switching Energy ⁽⁶⁾		615	950		

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to Case (IGBT)			.44	°C/W
$R_{\theta JC}$	Junction to Case (DIODE)			1.21	
W_T	Package Weight		29.2		gm

- ① Repetitive Rating: Pulse width limited by maximum junction temperature.
- ② For Combi devices, I_{ces} includes both IGBT and FRED leakages
- ③ See MIL-STD-750 Method 3471.
- ④ 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 24.)
- ⑤ 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 21, 22.)
- ⑥ E_{off} is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1. (See Figures 21, 23.)
- Repetitive Rating: Pulse width limited by maximum junction temperature.

APT Reserves the right to change, without notice, the specifications and information contained herein.

TYPICAL PERFORMANCE CURVES

APT40GP60JDQ2

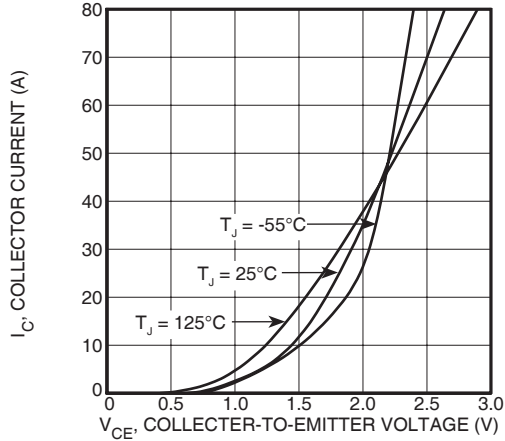


FIGURE 1, Output Characteristics ($T_J = 25^\circ\text{C}$)

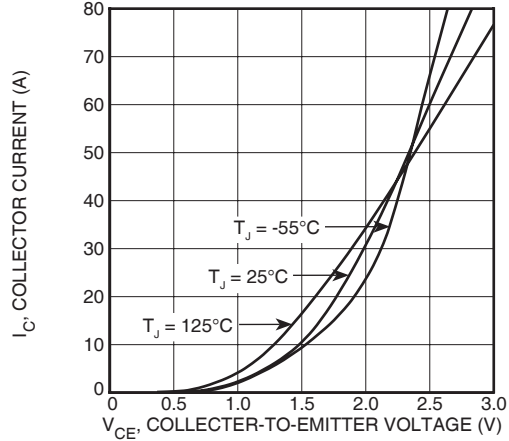


FIGURE 2, Output Characteristics ($T_J = 125^\circ\text{C}$)

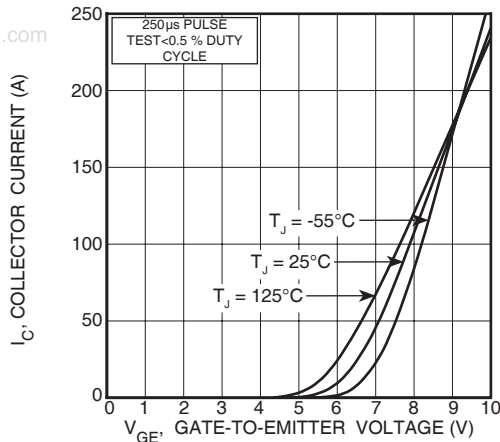


FIGURE 3, Transfer Characteristics

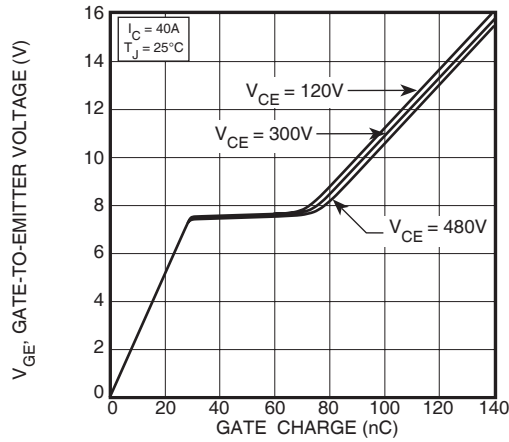


FIGURE 4, Gate Charge

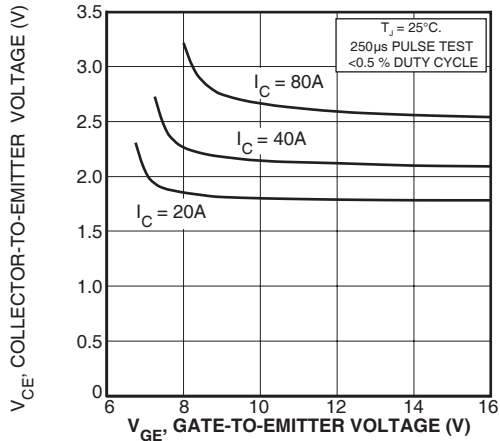


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

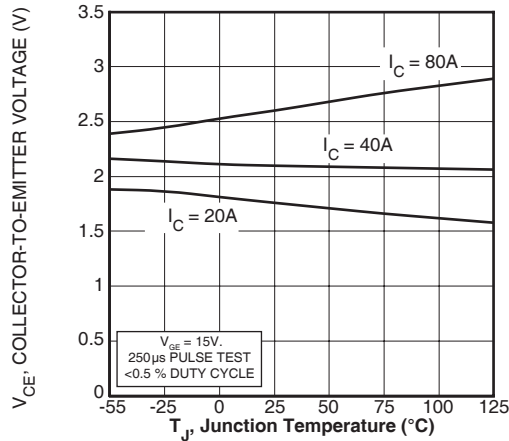


FIGURE 6, On State Voltage vs Junction Temperature

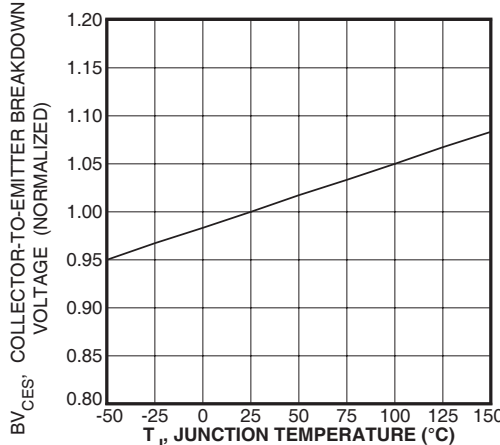


FIGURE 7, Breakdown Voltage vs. Junction Temperature

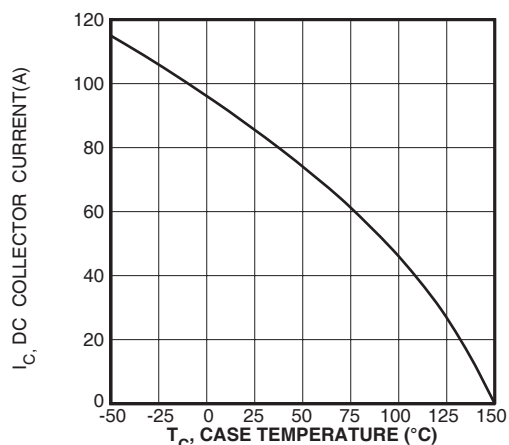


FIGURE 8, DC Collector Current vs Case Temperature

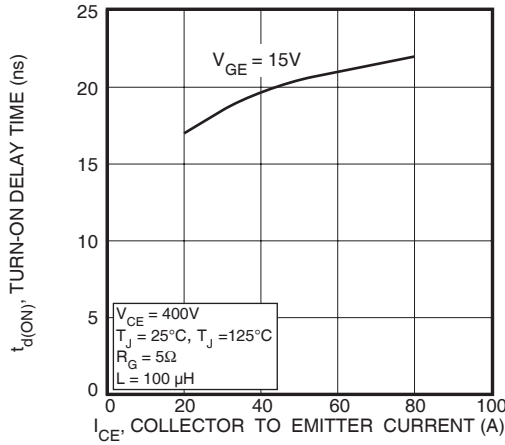


FIGURE 9, Turn-On Delay Time vs Collector Current

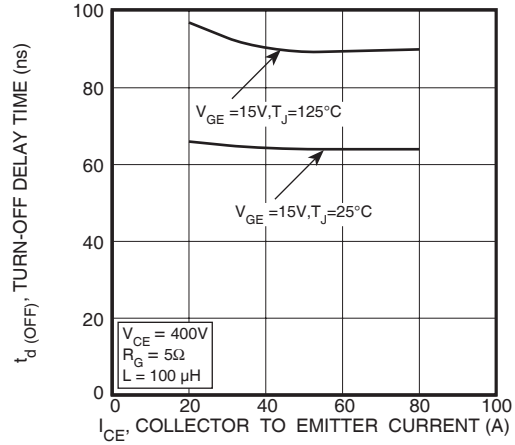


FIGURE 10, Turn-Off Delay Time vs Collector Current

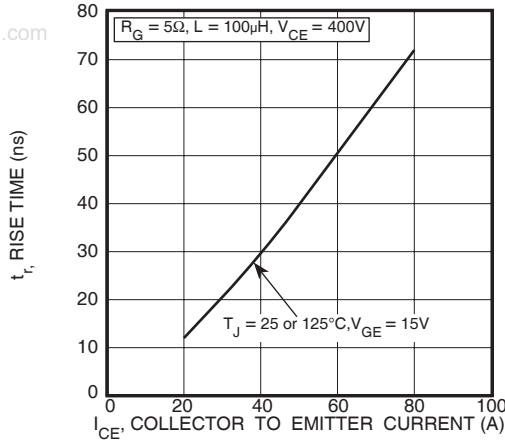


FIGURE 11, Current Rise Time vs Collector Current

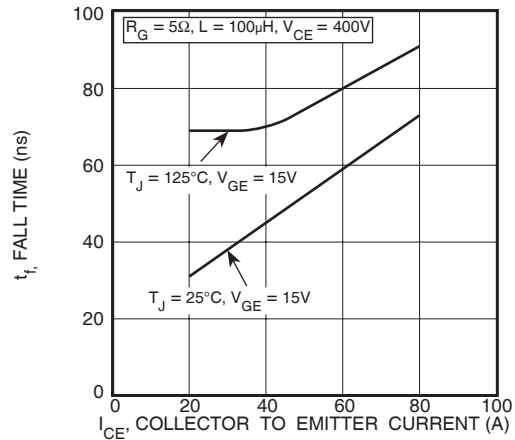


FIGURE 12, Current Fall Time vs Collector Current

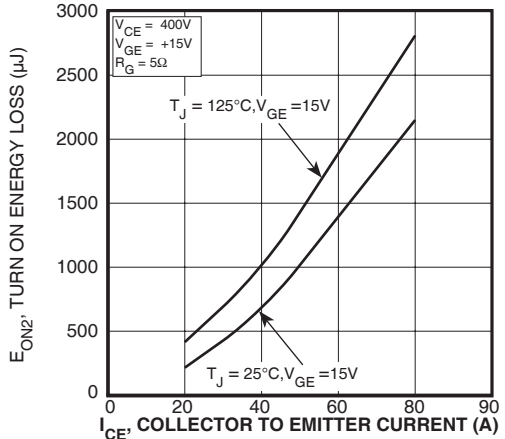


FIGURE 13, Turn-On Energy Loss vs Collector Current

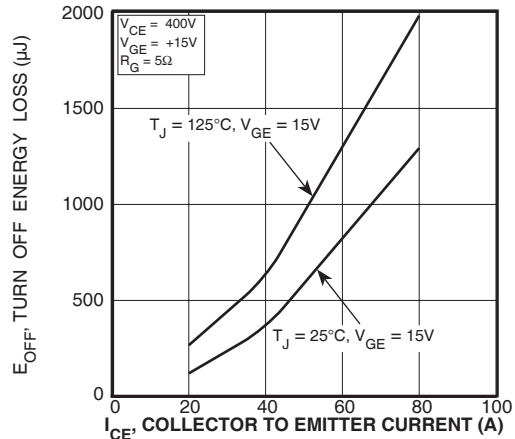


FIGURE 14, Turn Off Energy Loss vs Collector Current

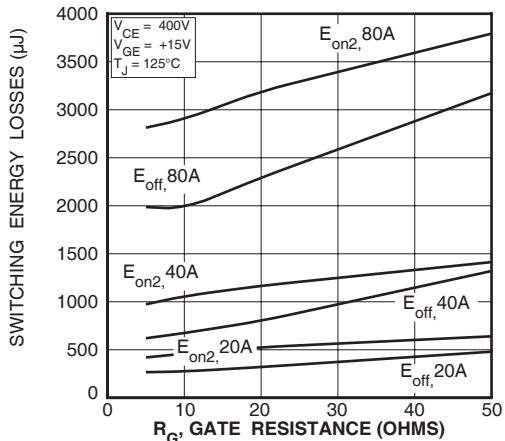


FIGURE 15, Switching Energy Losses vs. Gate Resistance

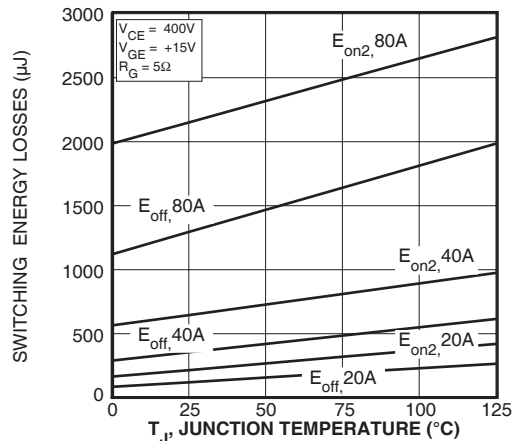


FIGURE 16, Switching Energy Losses vs Junction Temperature

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TYPICAL PERFORMANCE CURVES

APT40GP60JDQ2

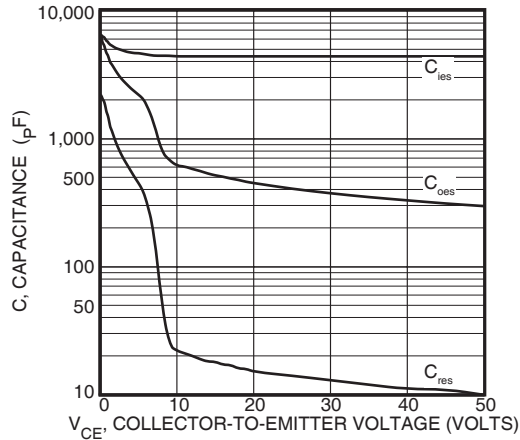


Figure 17, Capacitance vs Collector-To-Emitter Voltage

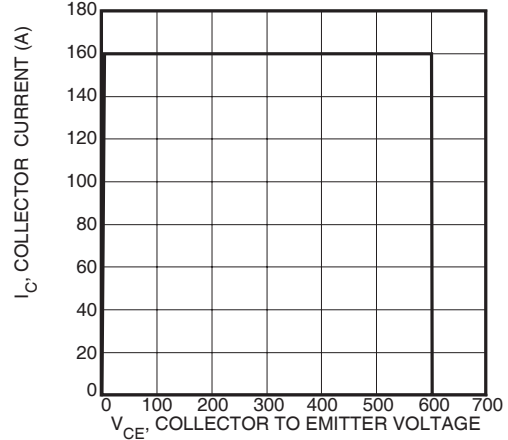


Figure 18, Minimum Switching Safe Operating Area

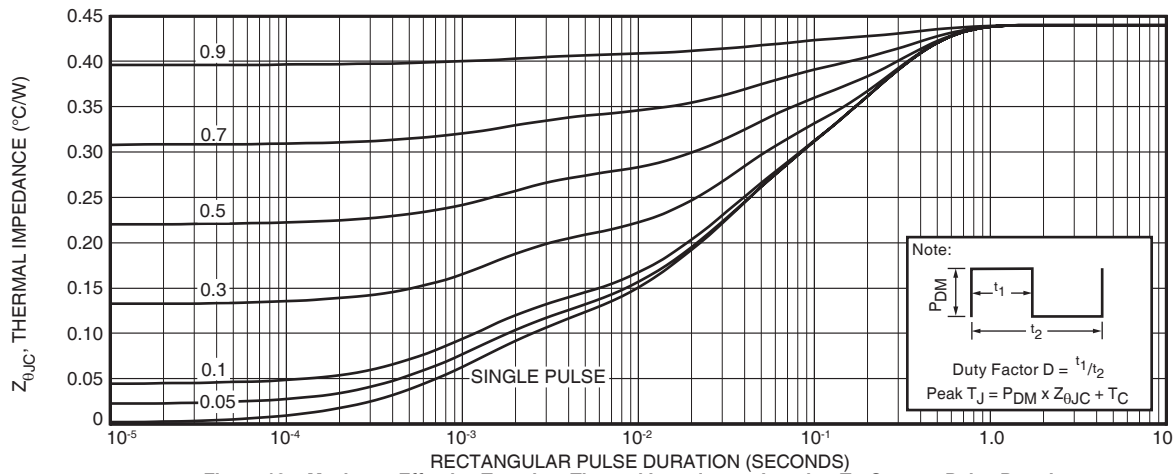


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

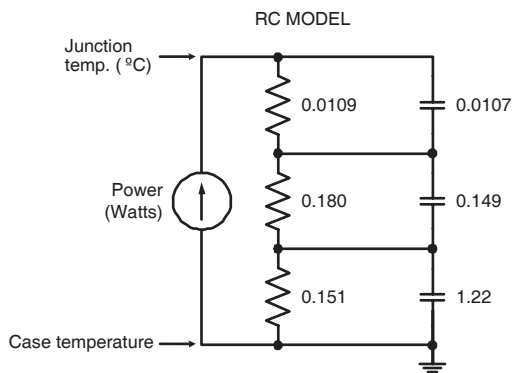


FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL

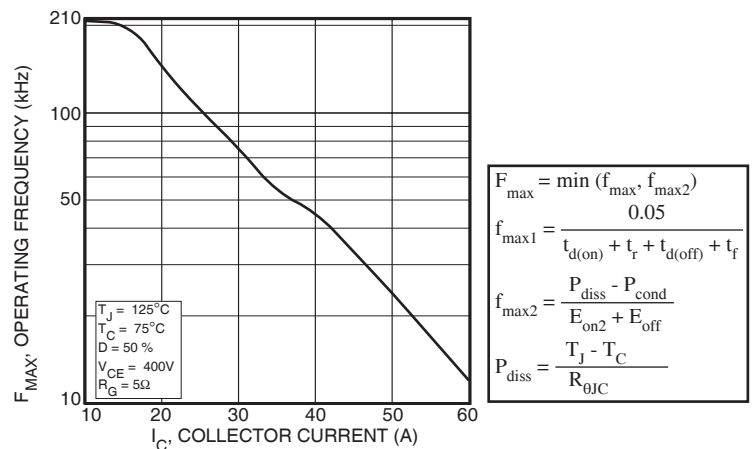


Figure 20, Operating Frequency vs Collector Current

$$F_{max} = \min(f_{max1}, f_{max2})$$

$$f_{max1} = \frac{0.05}{t_{d(on)} + t_r + t_{d(off)} + t_f}$$

$$f_{max2} = \frac{P_{diss} - P_{cond}}{E_{on2} + E_{off}}$$

$$P_{diss} = \frac{T_J - T_C}{R_{\theta JC}}$$

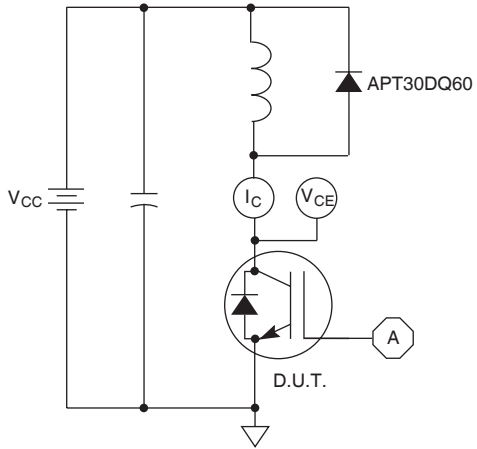


Figure 21, Inductive Switching Test Circuit

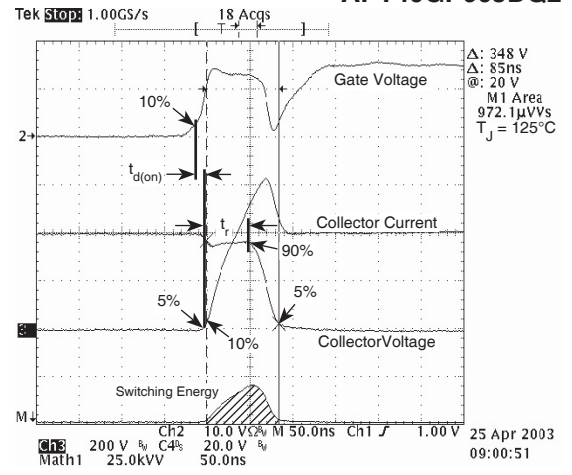


Figure 22, Turn-on Switching Waveforms and Definitions

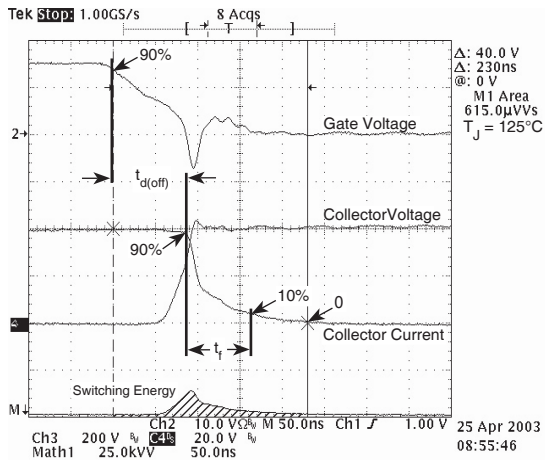


Figure 23, Turn-off Switching Waveforms and Definitions

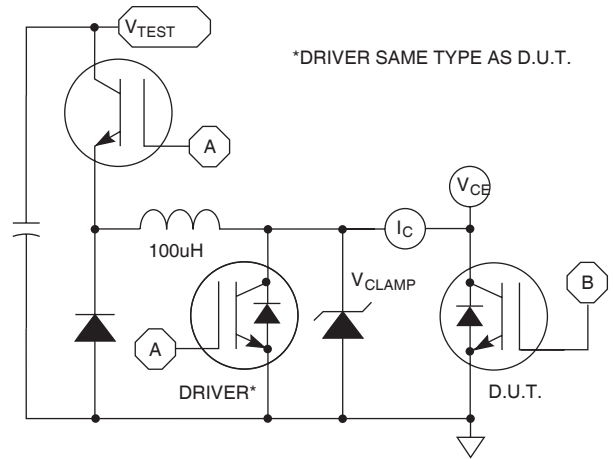


Figure 24, EON1 Test Circuit

ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

MAXIMUM RATINGS

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

Symbol	Characteristic / Test Conditions	APT40GP60JDQ2		UNIT
$I_F(\text{AV})$	Maximum Average Forward Current ($T_C = 99^\circ\text{C}$, Duty Cycle = 0.5)	30		Amps
$I_F(\text{RMS})$	RMS Forward Current (Square wave, 50% duty)	42		
I_{FSM}	Non-Repetitive Forward Surge Current ($T_J = 45^\circ\text{C}$, 8.3ms)	320		

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	MIN	TYP	MAX	UNIT
V_F	Forward Voltage		$I_F = 40\text{A}$	2.0	Volts
			$I_F = 80\text{A}$	2.5	
			$I_F = 40\text{A}, T_J = 125^\circ\text{C}$	1.7	

DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
t_{rr}	Reverse Recovery Time	$I_F = 1\text{A}, di_F/dt = -100\text{A}/\mu\text{s}, V_R = 30\text{V}, T_J = 25^\circ\text{C}$	-	21		ns
t_{rr}	Reverse Recovery Time	$I_F = 30\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 25^\circ\text{C}$	-	105		
Q_{rr}	Reverse Recovery Charge		-	115		nC
I_{RRM}	Maximum Reverse Recovery Current		-	3	-	Amps
t_{rr}	Reverse Recovery Time	$I_F = 30\text{A}, di_F/dt = -200\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	125		ns
Q_{rr}	Reverse Recovery Charge		-	465		nC
I_{RRM}	Maximum Reverse Recovery Current		-	7	-	Amps
t_{rr}	Reverse Recovery Time	$I_F = 30\text{A}, di_F/dt = -1000\text{A}/\mu\text{s}, V_R = 400\text{V}, T_C = 125^\circ\text{C}$	-	60		ns
Q_{rr}	Reverse Recovery Charge		-	830		nC
I_{RRM}	Maximum Reverse Recovery Current		-	23		Amps

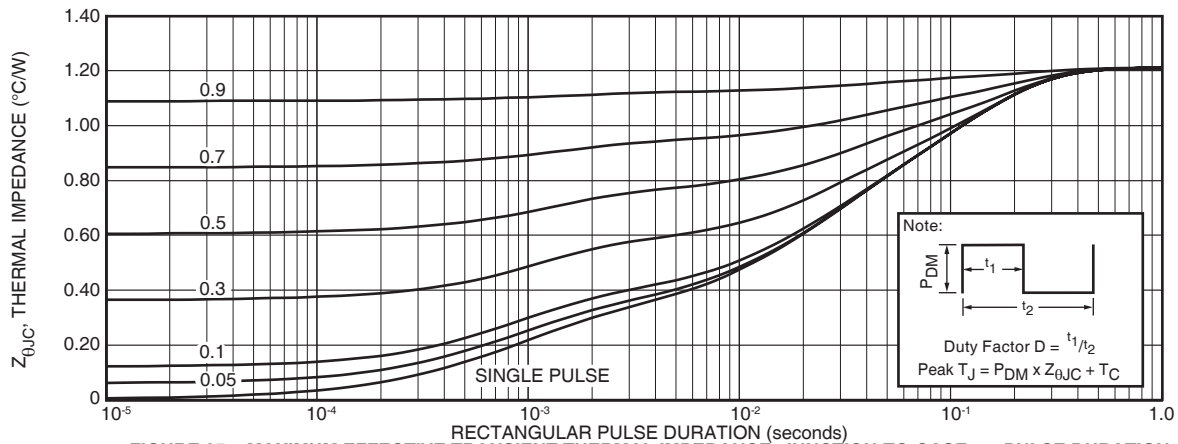


FIGURE 25a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

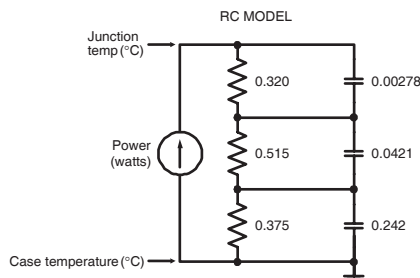


FIGURE 25b. TRANSIENT THERMAL IMPEDANCE MODEL

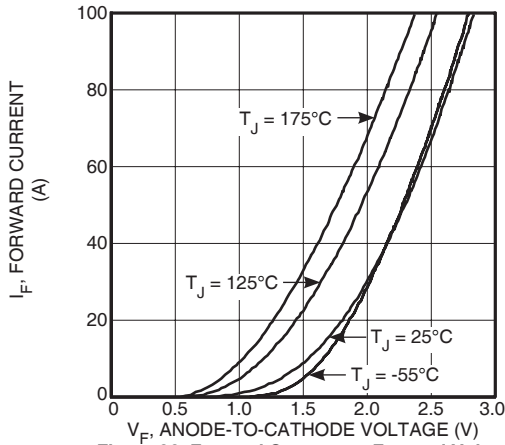


Figure 26. Forward Current vs. Forward Voltage

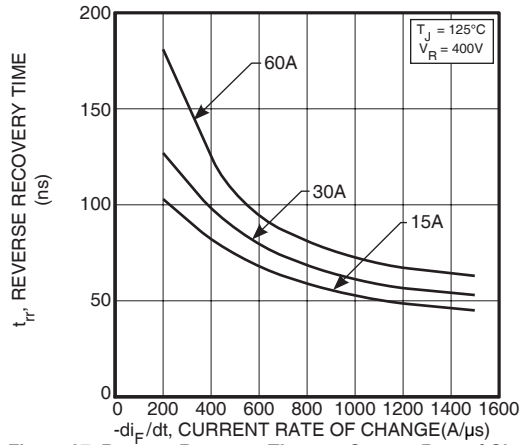


Figure 27. Reverse Recovery Time vs. Current Rate of Change

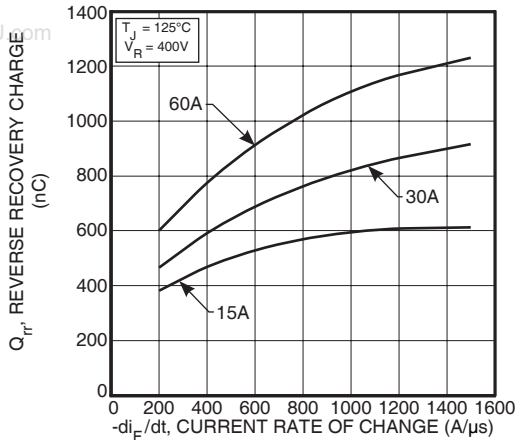


Figure 28. Reverse Recovery Charge vs. Current Rate of Change

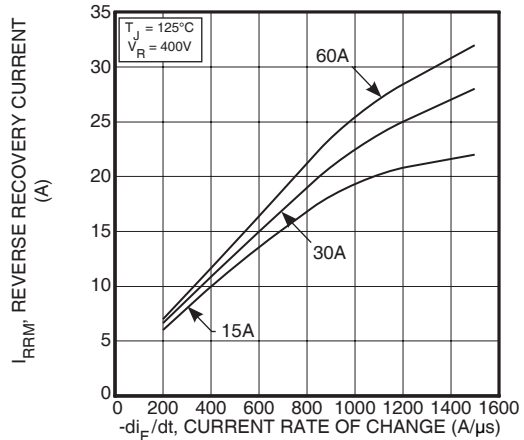


Figure 29. Reverse Recovery Current vs. Current Rate of Change

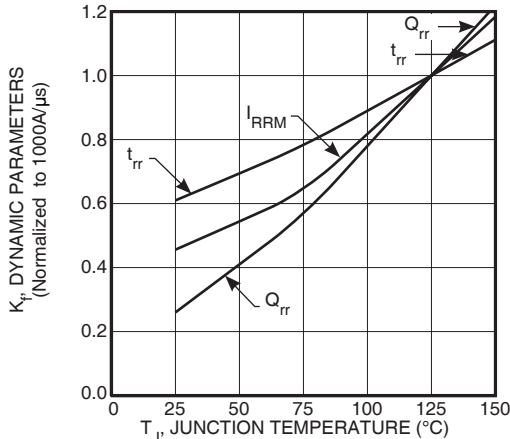


Figure 30. Dynamic Parameters vs. Junction Temperature

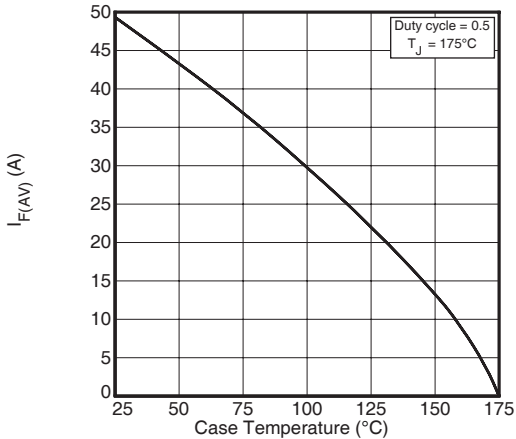


Figure 31. Maximum Average Forward Current vs. Case Temperature

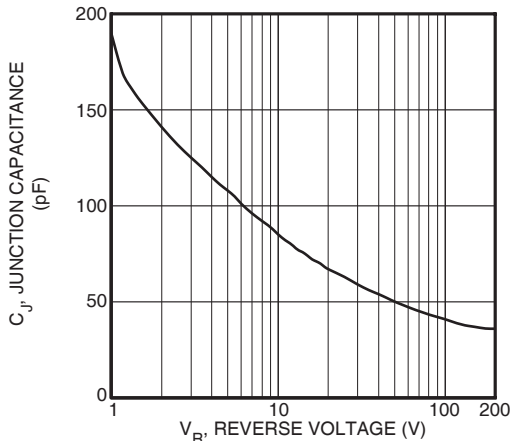


Figure 32. Junction Capacitance vs. Reverse Voltage

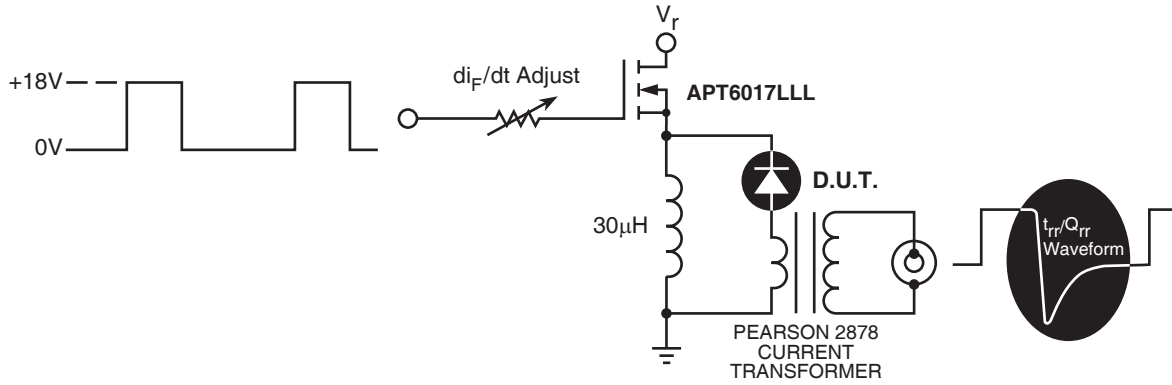


Figure 33. Diode Test Circuit

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- 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} .

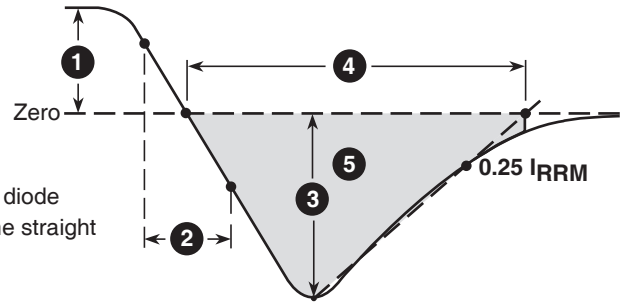


Figure 34. Diode Reverse Recovery Waveform and Definitions

SOT-227 (ISOTOP®) Package Outline

