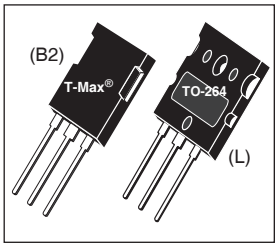
ADVANCED POWER TECHNOLOGY®

1200V

APT33GF120B2RDQ2 APT33GF120LRDQ2
APT33GF120B2RDQ2G* APT33GF120LRDQ2G*

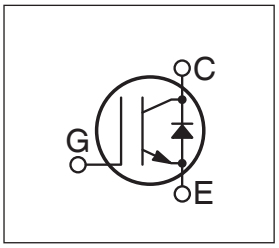
***G Denotes RoHS Compliant, Pb Free Terminal Finish.**

FAST IGBT & FRED



The Fast IGBT is a new generation of high voltage power IGBTs. Using Non-Punch through technology, the Fast IGBT combined with an APT free wheeling Ultra Fast Recovery Epitaxial Diode (FRED) offers superior ruggedness and fast switching speed.

- **Low Forward Voltage Drop**
- **High Freq. Switching to 20KHz**
- **RBSOA and SCSOA Rated**
- **Ultra Low Leakage Current**
- **Ultrafast Soft Recovery Anti-parallel Diode**



MAXIMUM RATINGS

All Ratings: T_C = 25°C unless otherwise specified.

Symbol	Parameter	APT33GF120B2_LRDQ2(G)	UNIT
V_{CES}	Collector-Emitter Voltage	1200	Volts
V_{GE}	Gate-Emitter Voltage	±30	
I_{C1}	Continuous Collector Current @ T_C = 25°C	64	Amps
I_{C2}	Continuous Collector Current @ T_C = 100°C	30	
I_{CM}	Pulsed Collector Current ①	75	
SSOA	Switching Safe Operating Area @ T_J = 150°C	75A @ 1200V	
P_D	Total Power Dissipation	357	Watts
T_J,T_{STG}	Operating and Storage Junction Temperature Range	-55 to 150	°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} = 0V, I_C = 1.5mA)	1200			Volts
$V_{GE(TH)}$	Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 1mA, T_j = 25°C)	4.5	5.5	6.5	
$V_{CE(ON)}$	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 25A, T_j = 25°C)	2.0	2.5	3.0	
	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 25A, T_j = 125°C)		xx		
I_{CES}	Collector Cut-off Current (V_{CE} = 1200V, V_{GE} = 0V, T_j = 25°C) ②			100	µA
	Collector Cut-off Current (V_{CE} = 1200V, V_{GE} = 0V, T_j = 125°C) ②			6000	
I_{GES}	Gate-Emitter Leakage Current (V_{GE} = ±20V)			±120	nA

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

APT Website - http://www.advancedpower.com

052-6280 Rev A 11-2005

DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	**Capacitance**		1855		pF
C_{oes}	Output Capacitance	V_{GE} = 0V, V_{CE} = 25V		230		
C_{res}	Reverse Transfer Capacitance	f = 1 MHz		110		
V_{GEP}	Gate-to-Emitter Plateau Voltage	Gate Charge		10		V
Q_g	Total Gate Charge ③	V_{GE} = 15V		170		nC
Q_{ge}	Gate-Emitter Charge	V_{CE} = 600V		19		
Q_{gc}	Gate-Collector ("Miller") Charge	I_C = 25A		100		
SSOA	Switching Safe Operating Area	T_J = 150°C, R_G = 4.3Ω, V_{GE} = 15V, L = 100µH, V_{CE} = 1200V	75			A
$t_{d(on)}$	Turn-on Delay Time	**Inductive Switching (25°C)**		14		ns
t_r	Current Rise Time	V_{CC} = 800V		17		
$t_{d(off)}$	Turn-off Delay Time	V_{GE} = 15V		185		
t_f	Current Fall Time	I_C = 25A		110		
E_{on1}	Turn-on Switching Energy ④	R_G = 4.3Ω		1315		µJ
E_{on2}	Turn-on Switching Energy (Diode) ⑤	T_J = +25°C		1930		
E_{off}	Turn-off Switching Energy ⑥			1515		
$t_{d(on)}$	Turn-on Delay Time	**Inductive Switching (125°C)**		14		ns
t_r	Current Rise Time	V_{CC} = 800V		17		
$t_{d(off)}$	Turn-off Delay Time	V_{GE} = 15V		220		
t_f	Current Fall Time	I_C = 25A		135		
E_{on1}	Turn-on Switching Energy ④	R_G = 4.3Ω		1325		µJ
E_{on2}	Turn-on Switching Energy (Diode) ⑤	T_J = +125°C		3325		
E_{off}	Turn-off Switching Energy ⑥			2145		

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to Case **(IGBT)**			.35	°C/W
$R_{\theta JC}$	Junction to Case **(DIODE)**			0.61	
W_T	Package Weight		6.10		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 clam ped 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.)

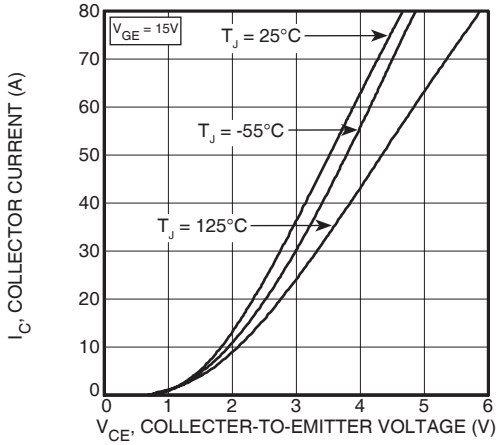


FIGURE 1, Output Characteristics(T_J = 25°C)

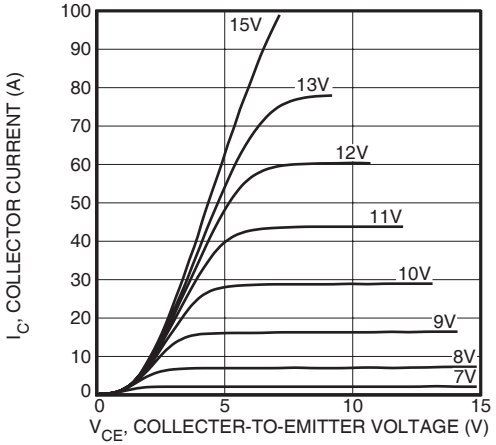


FIGURE 2, Output Characteristics (T_J = 125°C)

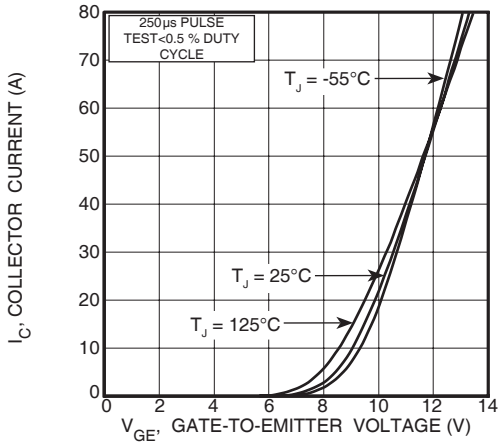


FIGURE 3, Transfer Characteristics

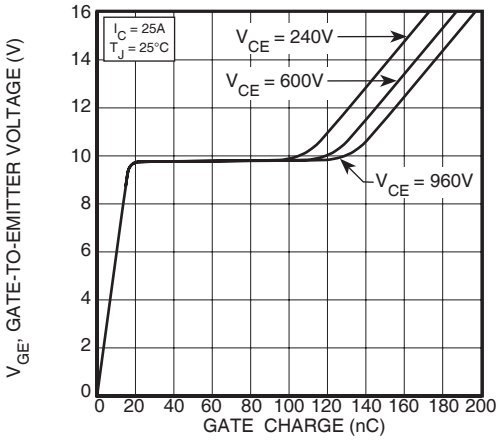


FIGURE 4, Gate Charge

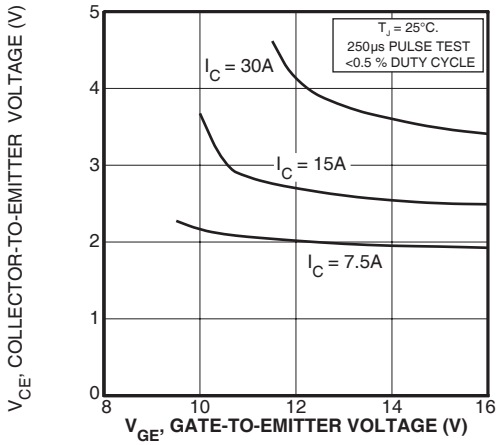


FIGURE 5, On State Voltage vs Gate-to- Emitter Voltage

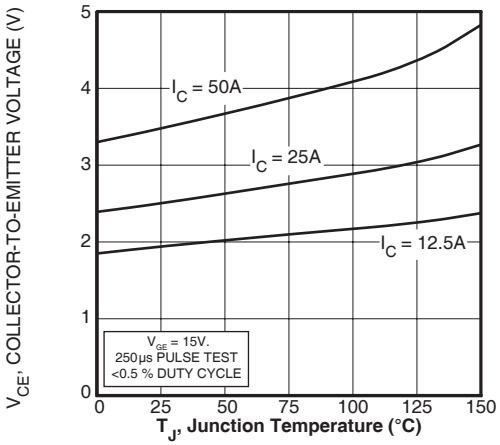


FIGURE 6, On State Voltage vs Junction Temperature

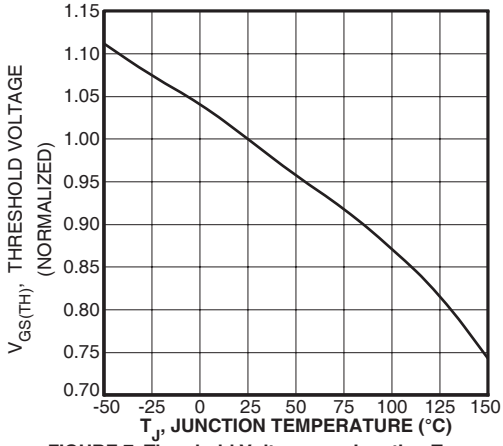


FIGURE 7, Threshold Voltage vs. Junction Temperature

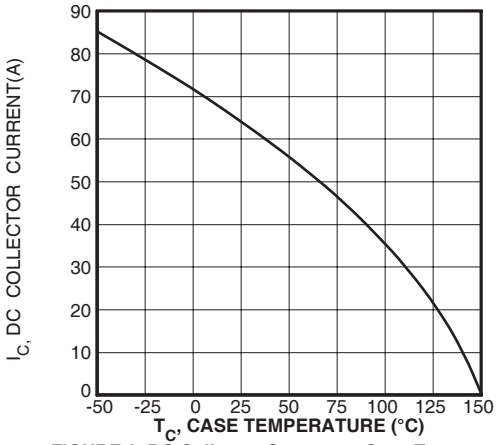


FIGURE 8, DC Collector Current vs Case Temperature

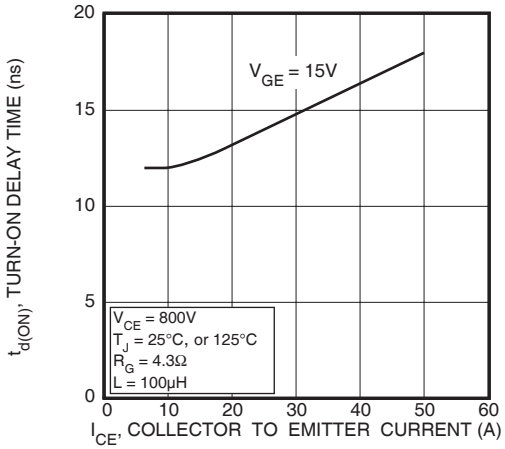


FIGURE 9, Turn-On Delay Time vs Collector Current

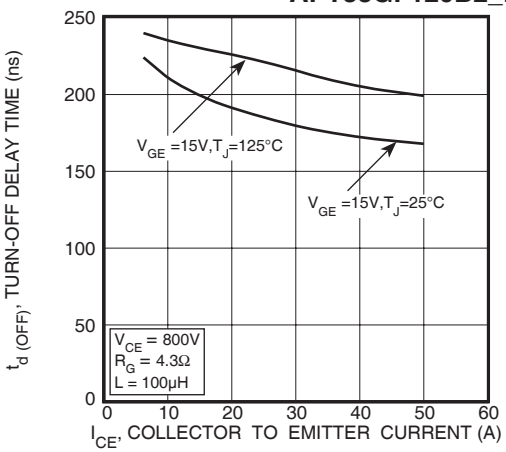


FIGURE 10, Turn-Off Delay Time vs Collector Current

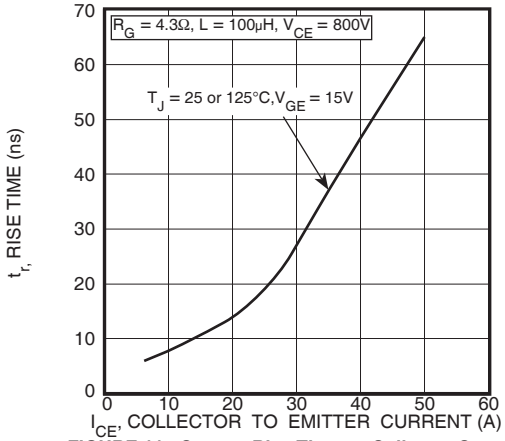


FIGURE 11, Current Rise Time vs Collector Current

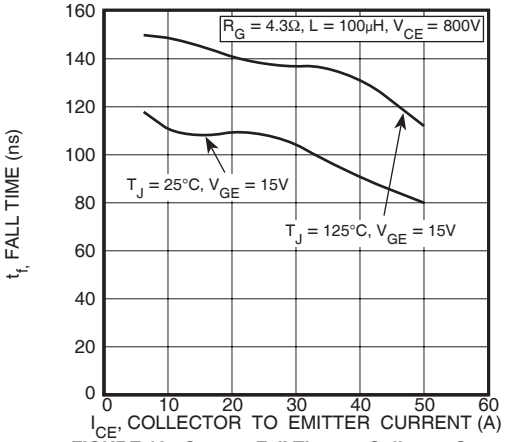


FIGURE 12, Current Fall Time vs Collector Current

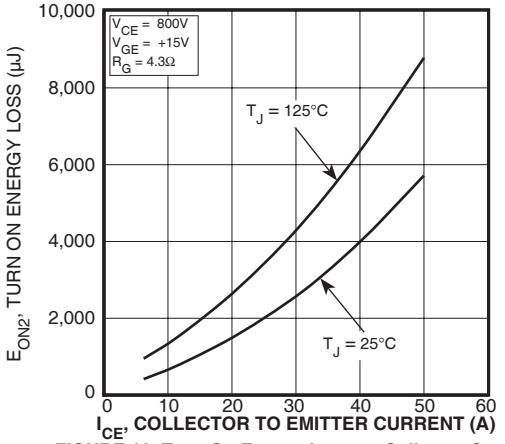


FIGURE 13, Turn-On Energy Loss vs Collector Current

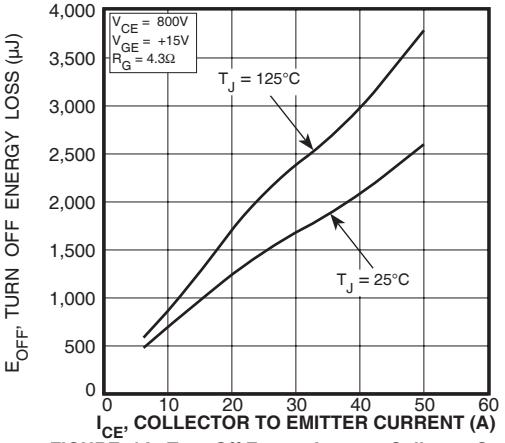


FIGURE 14, Turn Off Energy Loss vs Collector Current

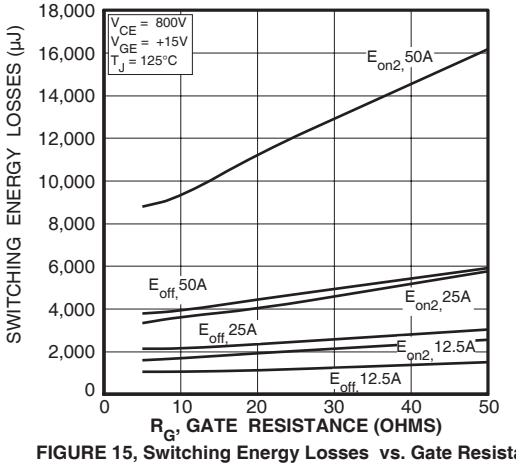


FIGURE 15, Switching Energy Losses vs. Gate Resistance

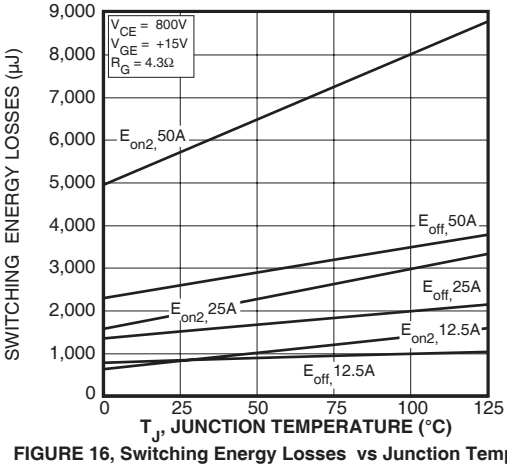


FIGURE 16, Switching Energy Losses vs Junction Temperature

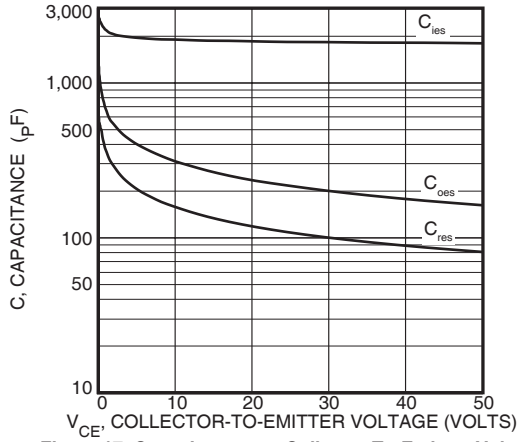


Figure 17, Capacitance vs Collector-To-Emitter Voltage

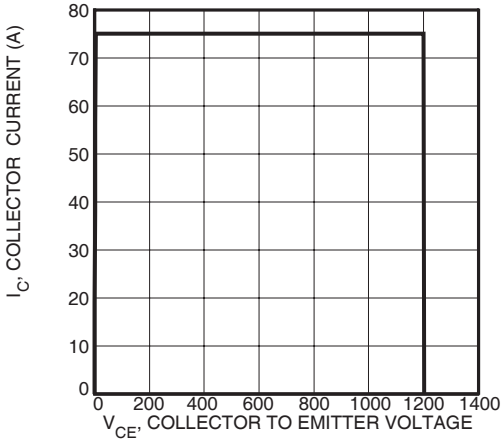


Figure 18,Minimim Switching Safe Operating Area

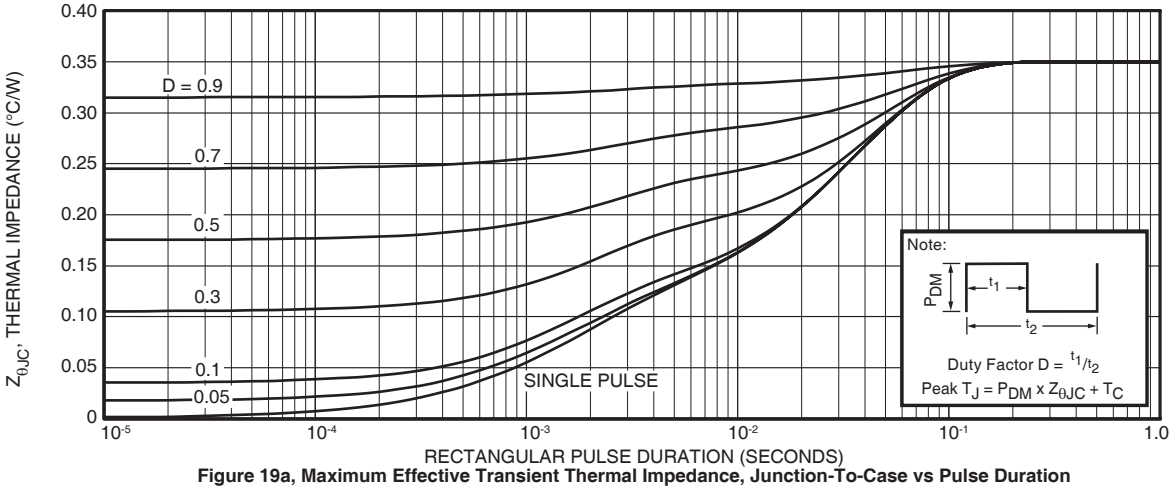


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

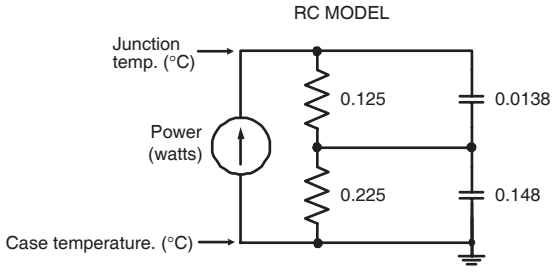


FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL

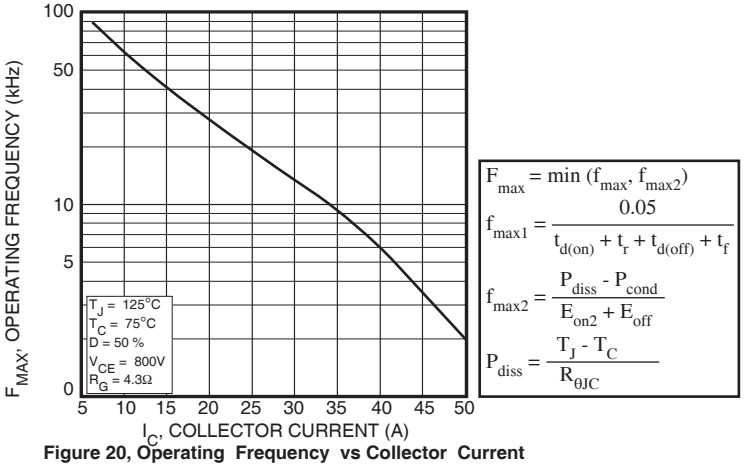


Figure 20, Operating Frequency vs Collector Current

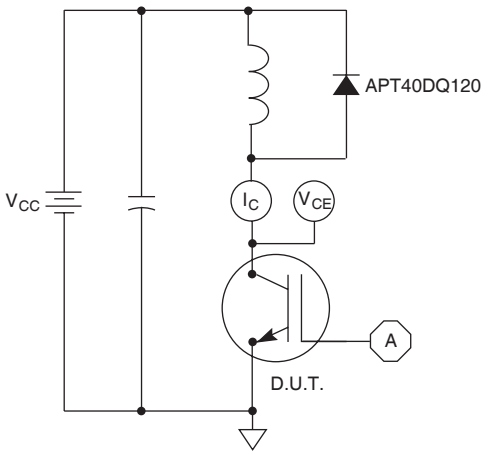


Figure 21, Inductive Switching Test Circuit

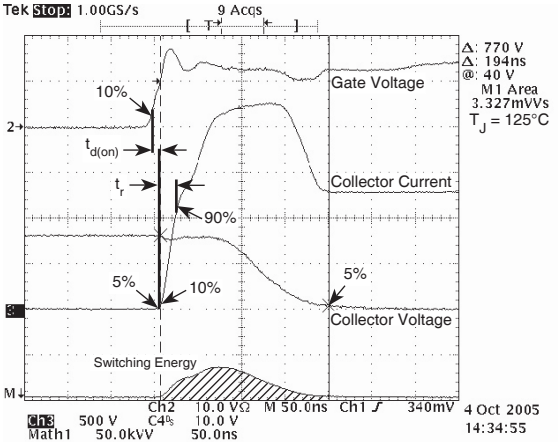


Figure 22, Turn-on Switching Waveforms and Definitions

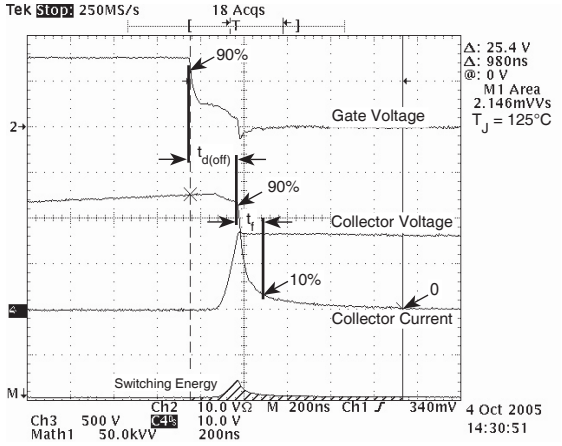


Figure 23, Turn-off Switching Waveforms and Definitions

ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

MAXIMUM RATINGS

All Ratings: T_C = 25°C unless otherwise specified.

Symbol	Characteristic / Test Conditions	APT33GF120B2_LRDQ2(G)			UNIT
$I_{F(AV)}$	Maximum Average Forward Current (T_C = 112°C, Duty Cycle = 0.5)		40		Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)		63		
I_{FSM}	Non-Repetitive Forward Surge Current (T_J = 45°C, 8.3ms)		210		

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Forward Voltage	I_F = 25A		2.46		Volts
		I_F = 50A		2.95		
		I_F = 25A, T_J = 125°C		1.83		

DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
t_{rr}	Reverse Recovery Time	I_F = 1A, di_F/dt = -100A/µs, V_R = 30V, T_J = 25°C	-	26		ns
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -200A/µs V_R = 800V, T_C = 25°C	-	350		ns
Q_{rr}	Reverse Recovery Charge		-	570		nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -200A/µs V_R = 800V, T_C = 125°C	-	430		ns
Q_{rr}	Reverse Recovery Charge		-	2200		nC
I_{RRM}	Maximum Reverse Recovery Current		-	9	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -1000A/µs V_R = 800V, T_C = 125°C	-	210		ns
Q_{rr}	Reverse Recovery Charge		-	3400		nC
I_{RRM}	Maximum Reverse Recovery Current		-	29		Amps

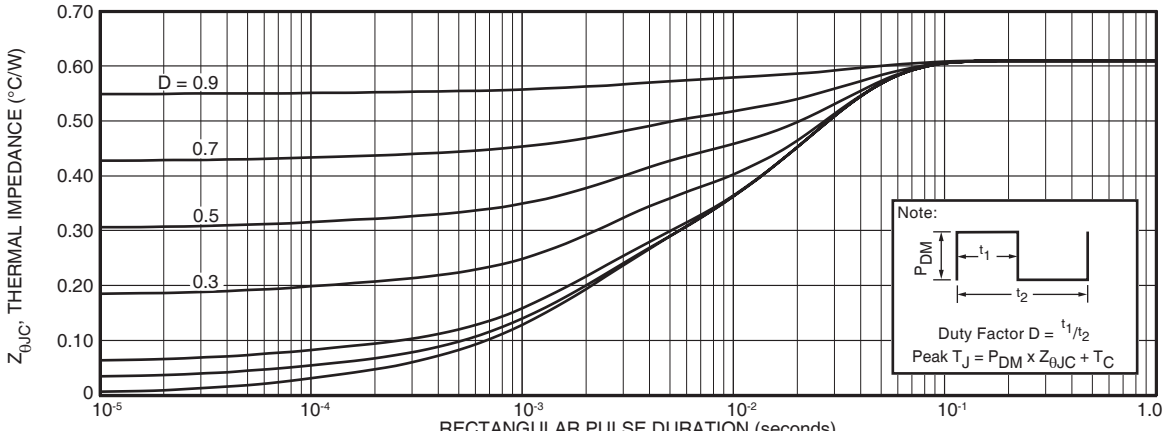


FIGURE 24a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

RC MODEL

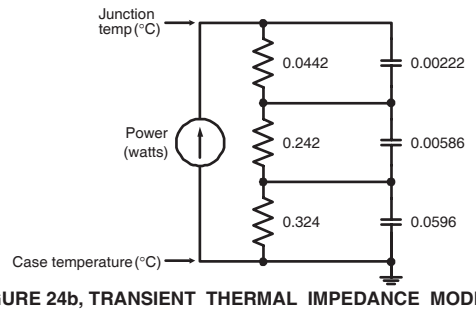


FIGURE 24b, TRANSIENT THERMAL IMPEDANCE MODEL

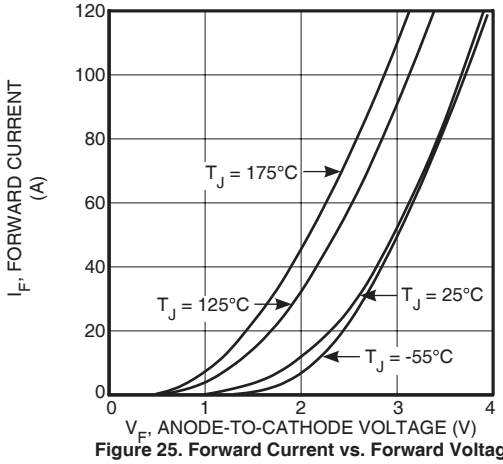


Figure 25. Forward Current vs. Forward Voltage

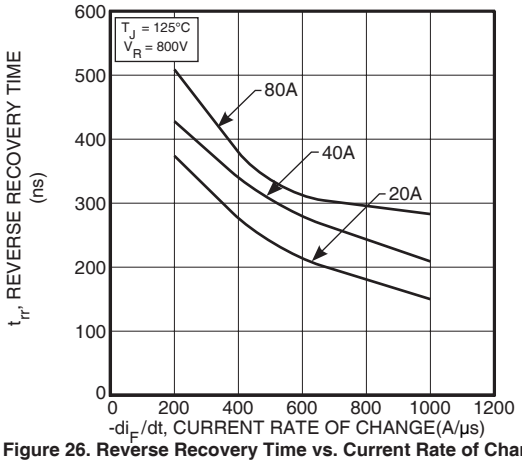


Figure 26. Reverse Recovery Time vs. Current Rate of Change

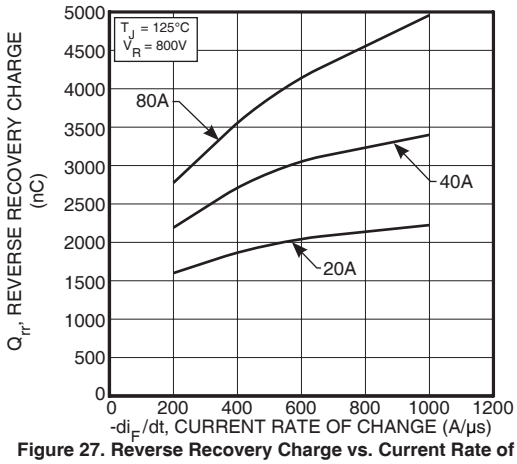


Figure 27. Reverse Recovery Charge vs. Current Rate of Change

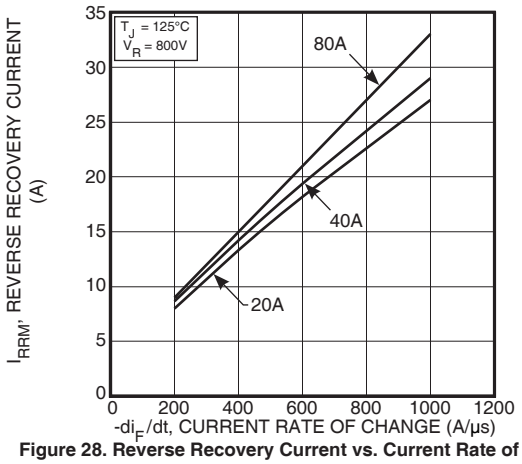


Figure 28. Reverse Recovery Current vs. Current Rate of Change

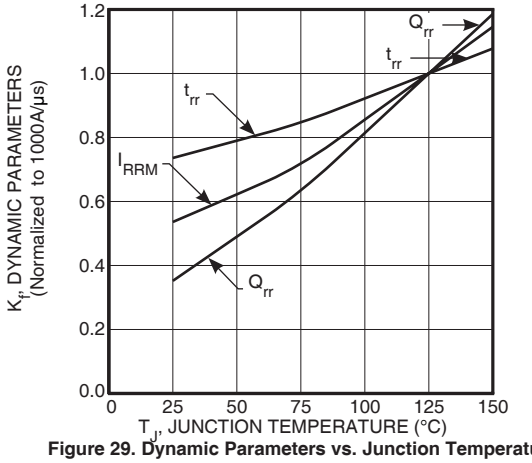


Figure 29. Dynamic Parameters vs. Junction Temperature

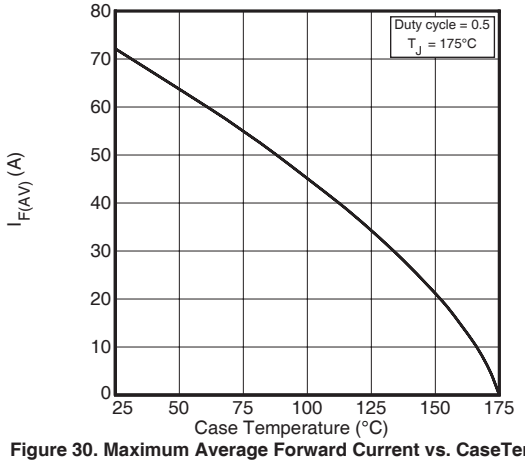


Figure 30. Maximum Average Forward Current vs. CaseTemperature

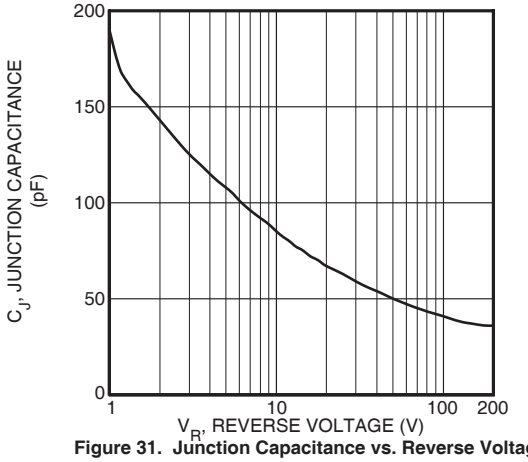


Figure 31. Junction Capacitance vs. Reverse Voltage

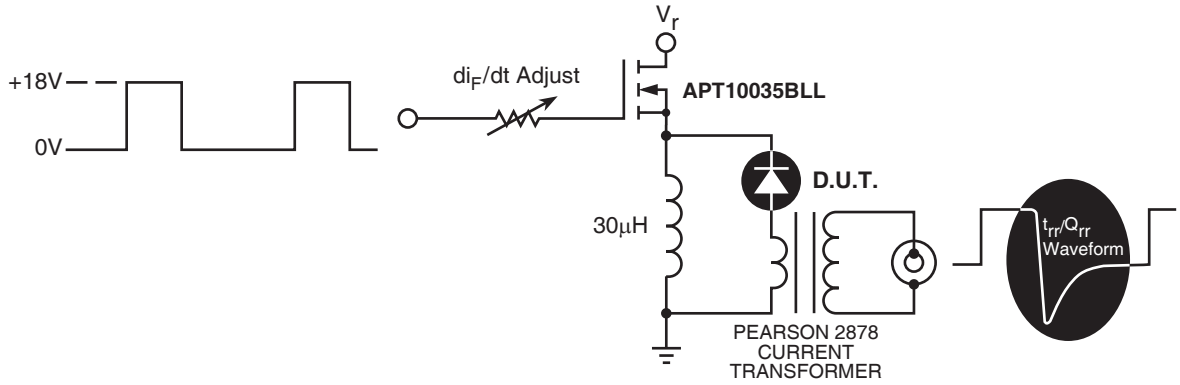


Figure 32. Diode Test Circuit

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 $0.25 \bullet I_{RRM}$ passes through zero.
5. Q_{rr} - Area Under the Curve Defined by I_{RRM} and t_{rr}.

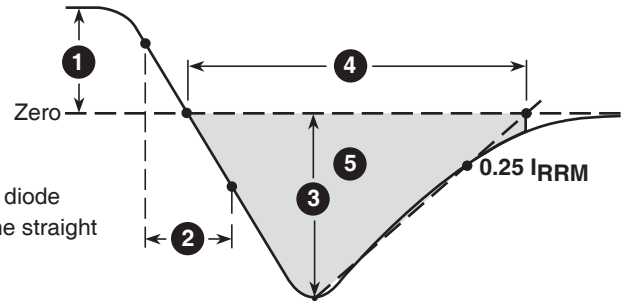
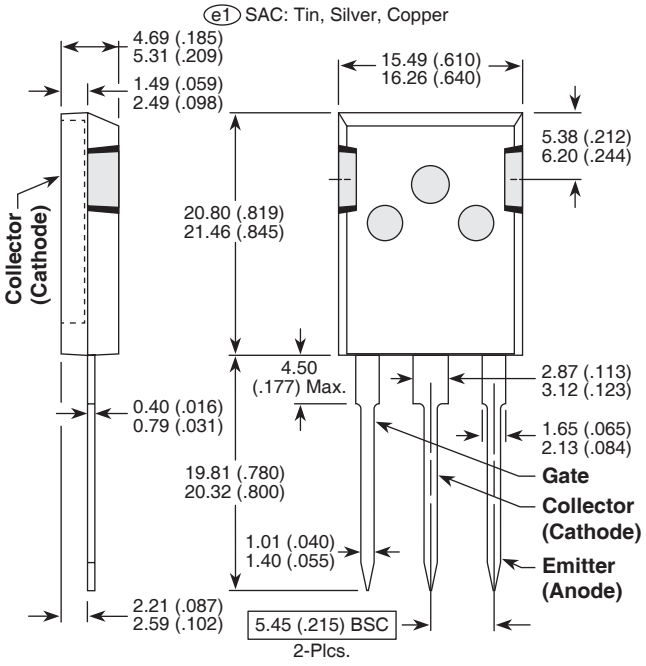


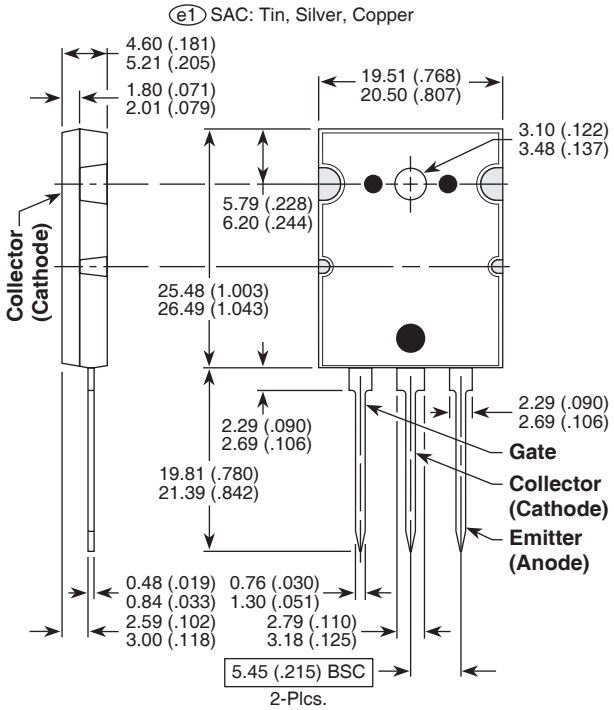
Figure 33, Diode Reverse Recovery Waveform and Definitions

T-MAX® (B2) Package Outline



Dimensions in Millimeters and (Inches)

TO-264 (L) Package Outline



Dimensions in Millimeters and (Inches)