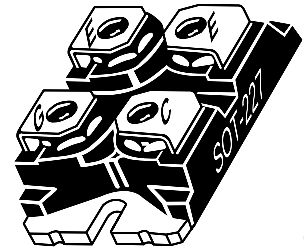
ADVANCED POWER TECHNOLOGY®

APT60GF120JRD

1200V

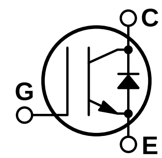
Fast IGBT & FRED



ISOTOP®

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 ultraFast Recovery Epitaxial Diode (FRED) offers superior ruggedness and fast switching speed
.

- **Low Forward Voltage Drop**
- **Low Tail Current**
- **RBSOA and SCSOA Rated**
- **Ultrafast Soft Recovery Antiparallel Diode**
- **20 kHz operation @ 800V, 24A**
- **10 kHz operation @ 800V, 40A**
- **Ultra Low Leakage Current**



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

Symbol	Parameter	APT60GF120JRD	UNIT
V_{CES}	Collector-Emitter Voltage	1200	
V_{GE}	Gate-Emitter Voltage	±20	Volts
V_{GEM}	Gate-Emitter Voltage Transient	±30	
I_{C1}	Continuous Collector Current @ T_C = 25°C	115	
I_{C2}	Continuous Collector Current @ T_C = 110°C	60	Amps
I_{CM}	Pulsed Collector Current ① @ T_C = 25°C	360	
RBSOA	Reverse Bias Safe Operating Area @ T_J = 150°C	360A @ 960V	
P_D	Total Power Dissipation	521	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	UNIT
V_{GE}(TH)	Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 500μA, T_j = 25°C)	3	4.5	6	
V_{CE}(ON)	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 60A, T_j = 25°C)		2.1	3.4	Volts
	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 60A, T_j = 125°C)		2.5	3.4	
I_{CES}	Collector Cut-off Current (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 25°C)②			500	mA
	Collector Cut-off Current (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 125°C)②			3000	
I_{GES}	Gate-Emitter Leakage Current (V_{GE} = ±20V, V_{CE} = 0V)			±100	nA

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

052-6259 Rev B 8-2002

DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	**Capacitance** V_{GE} = 0V, V_{CE} = 25V f = 1 MHz		7080		pF
C_{oes}	Output Capacitance			815		
C_{res}	Reverse Transfer Capacitance			441		
V_{GEP}	Gate-to-Emitter Plateau Voltage	**Gate Charge** V_{GE} = 15V V_{CE} = 600V I_C = 60A		9		V
Q_g	Total Gate Charge ③			695		nC
Q_{ge}	Gate-Emitter Charge			65		
Q_{gc}	Gate-Collector ("Miller") Charge			390		
RBSOA	Reverse Bias Safe Operating Area	T_J = 150°C, R_G = 5Ω, V_{GE} = 15V, L = 100µH, V_{CE} = 960V	360			A
$t_{d(on)}$	Turn-on Delay Time	**Inductive Switching (25°C)** V_{CC} = 800V V_{GE} = 15V I_C = 60A R_G = 5Ω T_J = +25°C		52		ns
t_r	Current Rise Time			79		
$t_{d(off)}$	Turn-off Delay Time			676		
t_f	Current Fall Time			56		
E_{on1}	Turn-on Switching Energy ④			TBD		µJ
E_{on2}	Turn-on Switching Energy (Diode)⑤			8404		
E_{off}	Turn-off Switching Energy ⑥			6806		
$t_{d(on)}$	Turn-on Delay Time	**Inductive Switching (125°C)** V_{CC} = 800V V_{GE} = 15V I_C = 60A R_G = 5Ω T_J = +125°C		52		ns
t_r	Current Rise Time			65		
$t_{d(off)}$	Turn-off Delay Time			764		
t_f	Current Fall Time			126		
E_{on1}	Turn-on Switching Energy ④			TBD		µJ
E_{on2}	Turn-on Switching Energy (Diode) ⑤			11878		
E_{off}	Turn-off Switching Energy ⑥			8955		

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\Theta JC}$	Junction to Case (IGBT)			.24	°C/W
$R_{\Theta JC}$	Junction to Case (DIODE)			.66	
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. A Combi device is used for the clamping diode as shown in the E_{on2} test circuit. (See Figures 21, 22.)

⑥ E_{off} is the clamped inductive turn-off energy. (See Figures 21, 23.)

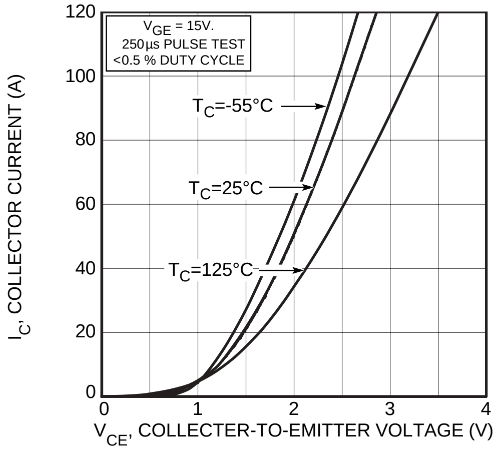


FIGURE 1, Output Characteristics(V_{GE} = 15V)

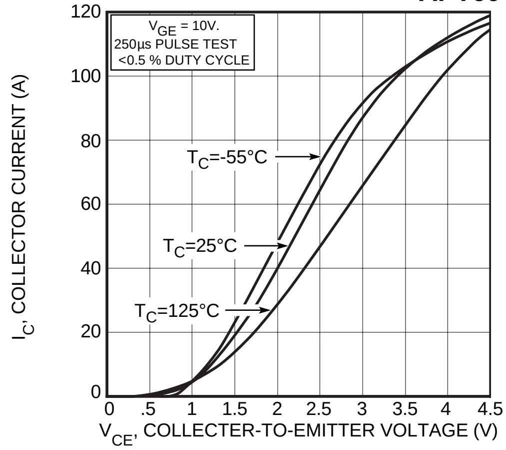


FIGURE 2, Output Characteristics (V_{GE} = 10V)

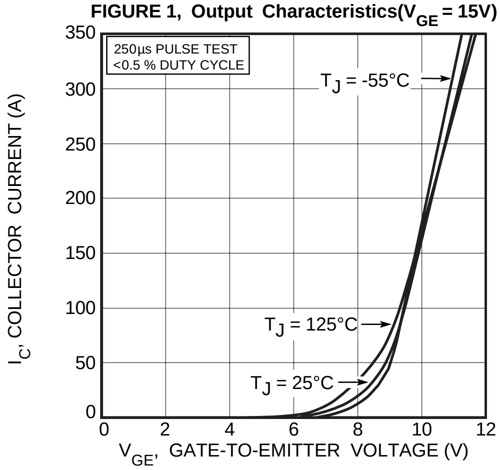


FIGURE 3, Transfer Characteristics

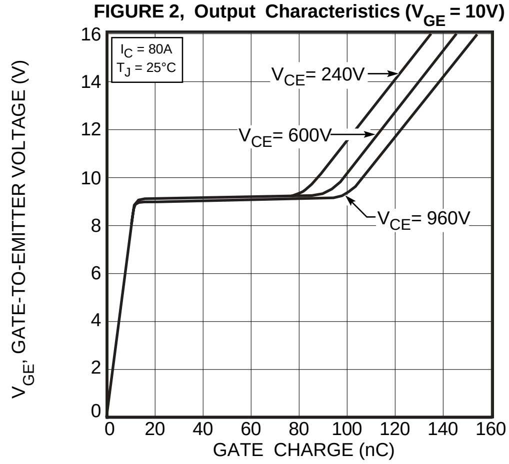


FIGURE 4, Gate Charge

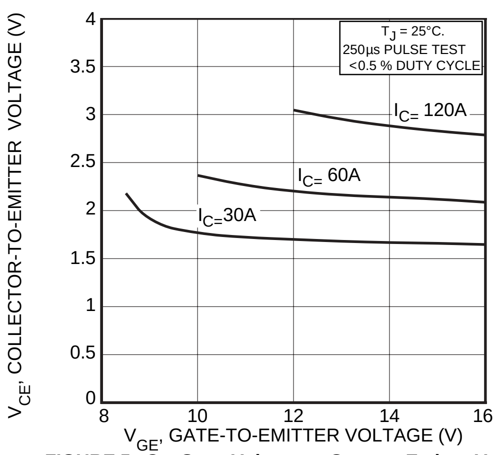


FIGURE 5, On State Voltage vs Gate-to- Emitter Voltage

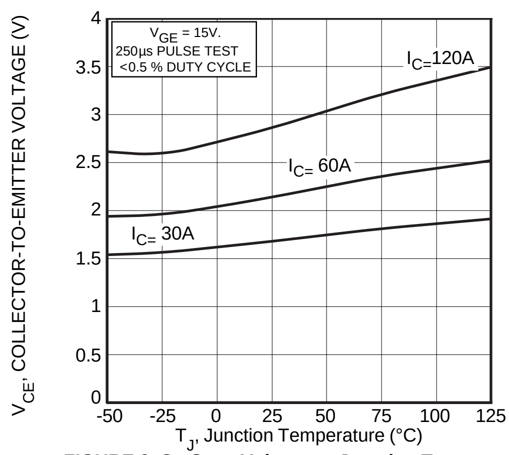


FIGURE 6, On State Voltage vs Junction Temperature

BV_{CES}, COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE (NORMALIZED)

1.2, 1.15, 1.1, 1.05, 1.0, 0.95, 0.90, 0.85, 0.8

Graph does not apply

-50, -25, 0, 25, 50, 75, 100, 125

T_J, JUNCTION TEMPERATURE (°C)

FIGURE 7, Breakdown Voltage vs. Junction Temperature

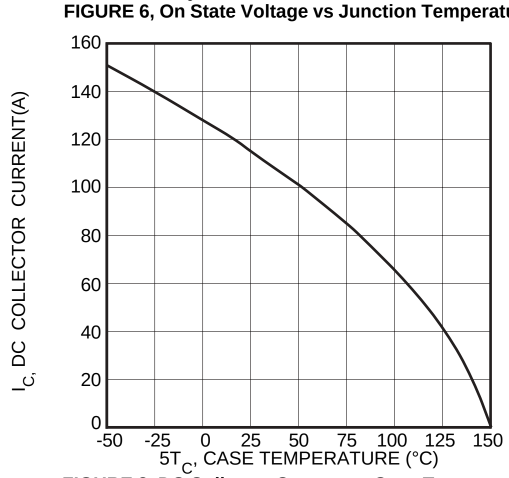


FIGURE 8, DC Collector Current vs Case Temperature

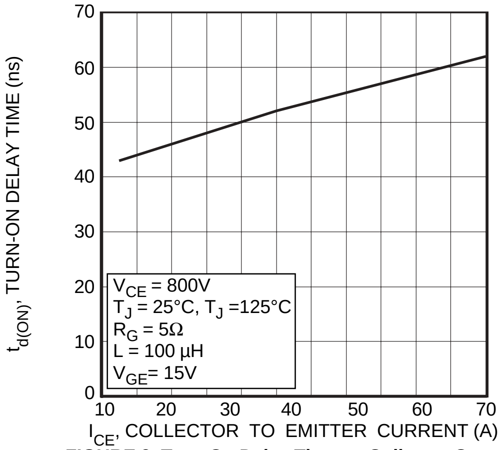


FIGURE 9, Turn-On Delay Time vs Collector Current

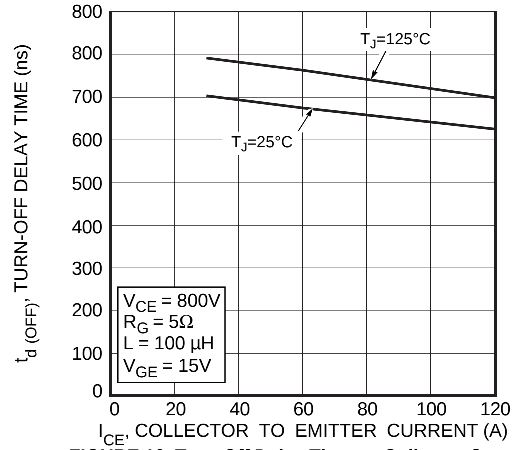


FIGURE 10, Turn-Off Delay Time vs Collector Current

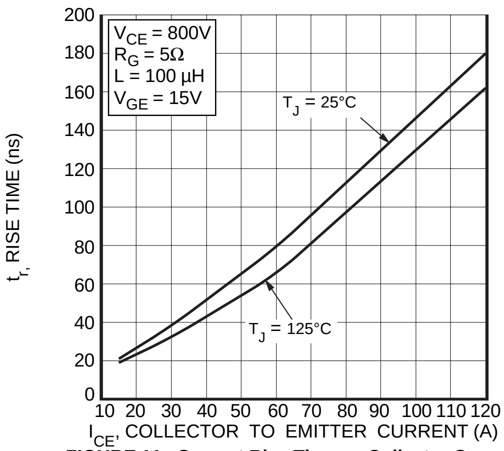


FIGURE 11, Current Rise Time vs Collector Current

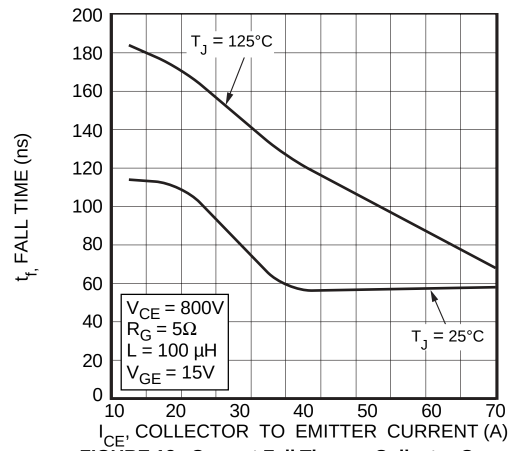


FIGURE 12, Current Fall Time vs Collector Current

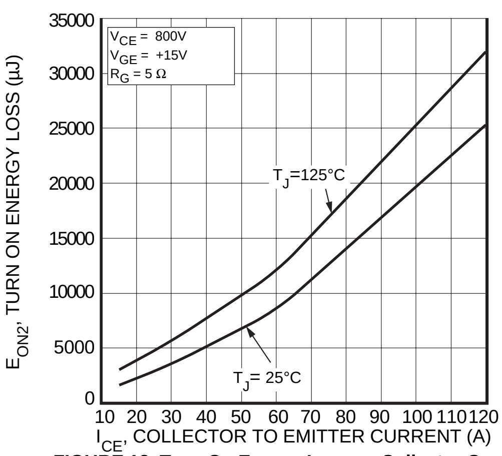


FIGURE 13, Turn-On Energy Loss vs Collector Current

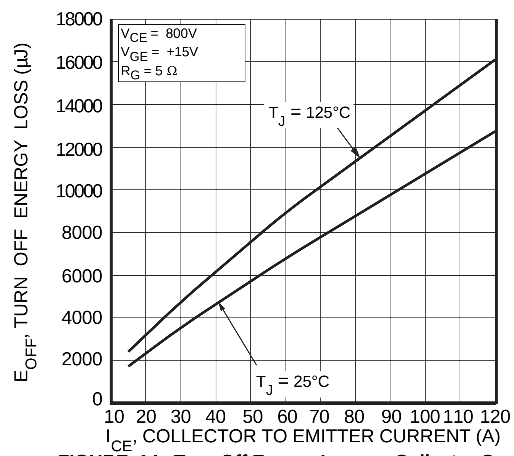


FIGURE 14, Turn Off Energy Loss vs Collector Current

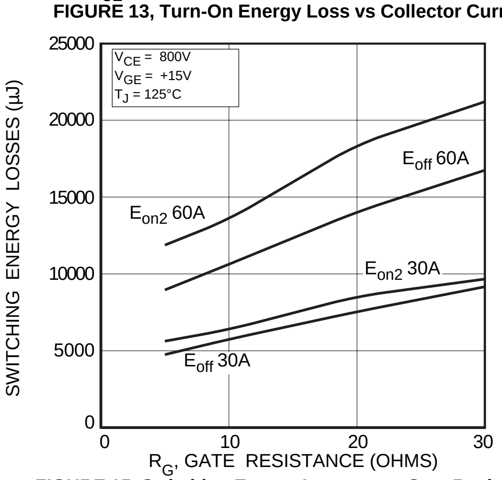


FIGURE 15, Switching Energy Losses vs. Gate Resistance

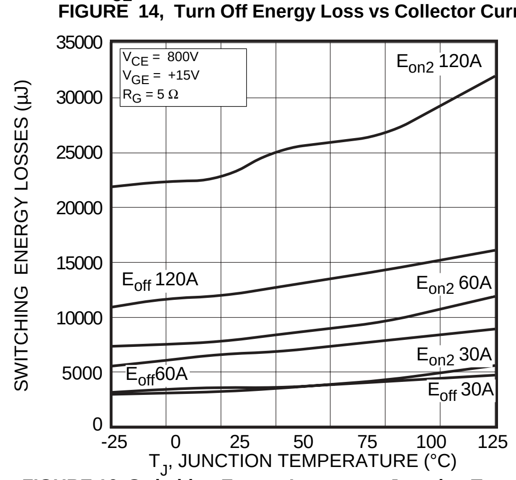


FIGURE 16, Switching Energy Losses vs Junction Temperature

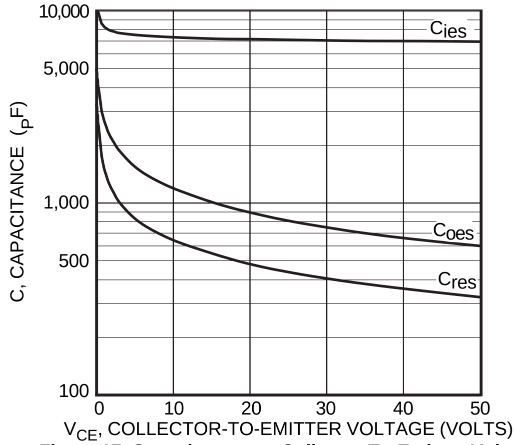


Figure 17, Capacitance vs Collector-To-Emitter Voltage

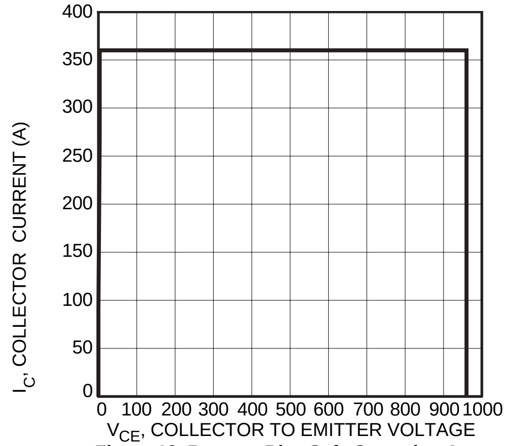


Figure 18, Reverse Bias Safe Operating Area

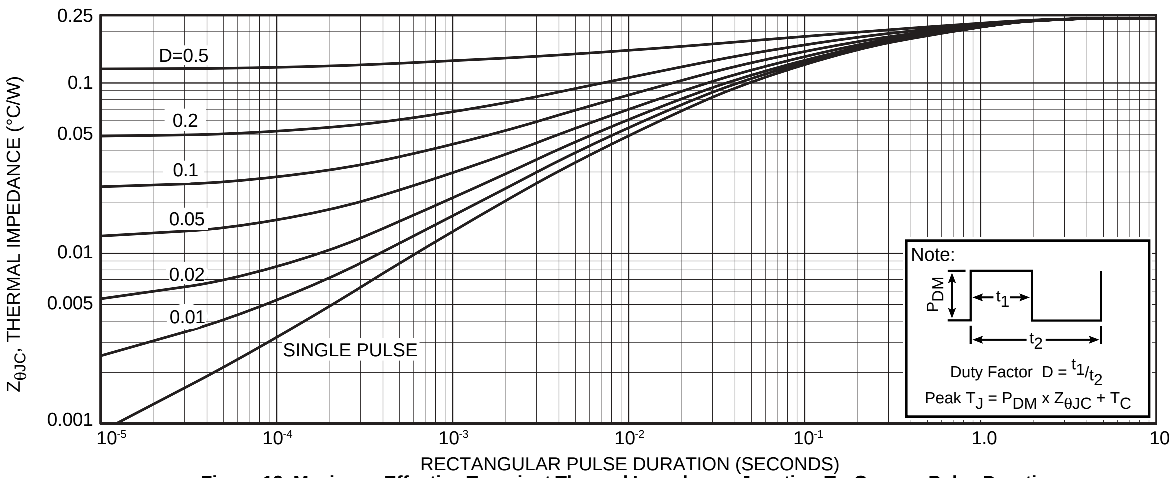


Figure 19, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

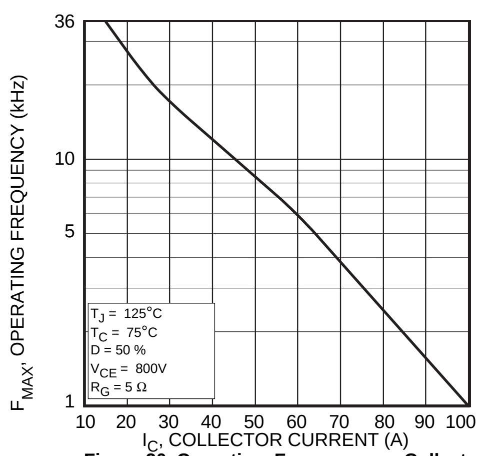


Figure 20, Operating Frequency vs Collector Current

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

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

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

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

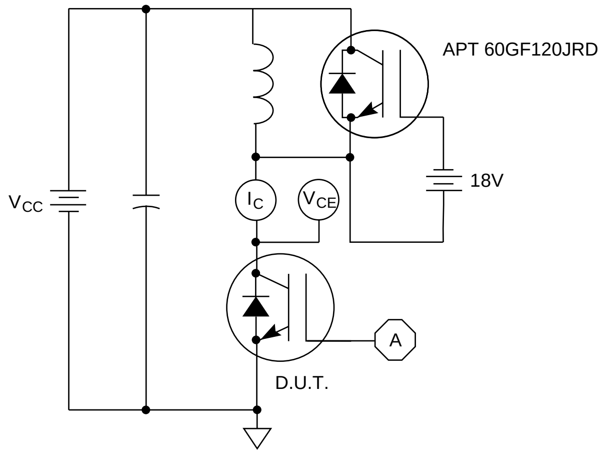


Figure 21. Inductive Switching Test Circuit

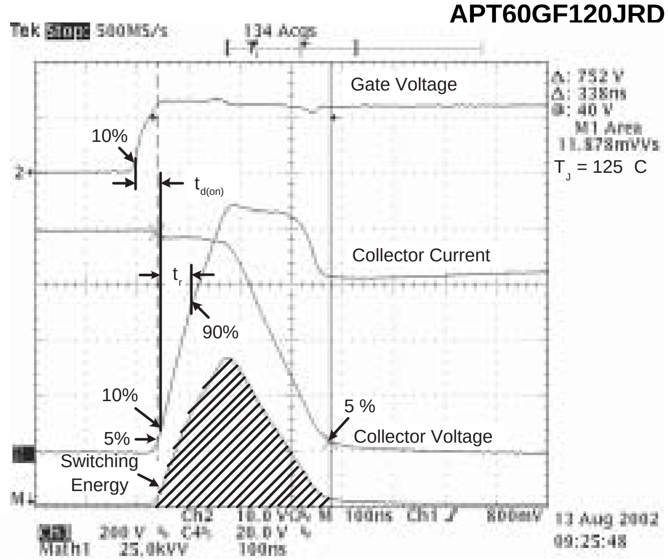


Figure 22, Turn-on Switching Waveforms and Definitions

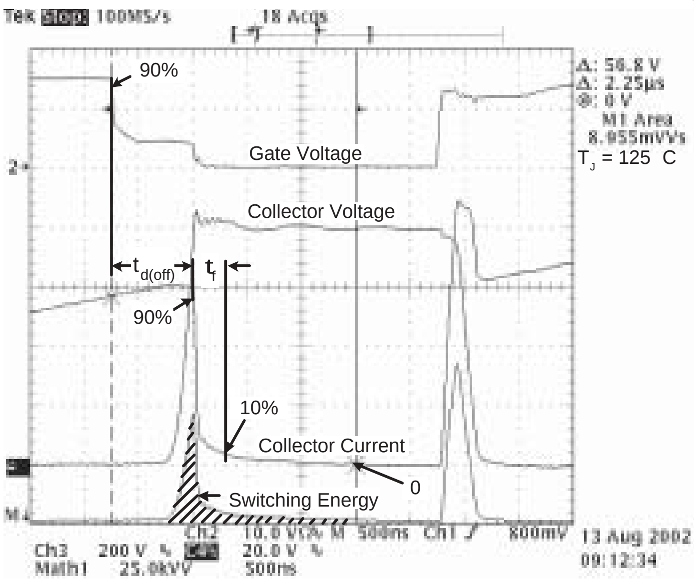


Figure 23, Turn-off Switching Waveforms and Definitions

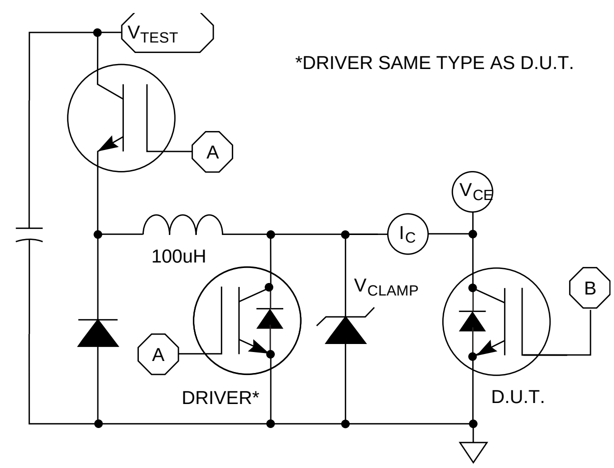


Figure 24, E_{ON1} Test Circuit

ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

MAXIMUM RATINGS

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

Symbol	Characteristic / Test Conditions	APT60GF120JRD			UNIT
I_F(AV)	Maximum Average Forward Current (T_C = 80°C, Duty Cycle = 0.5)		60		Amps
I_F(RMS)	RMS Forward Current		100		
I_{FSM}	Non-Repetitive Forward Surge Current (T_J = 45°C, 8.3ms)		540		

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Maximum Forward Voltage	I_F = 60A			2.5	Volts
		I_F = 120A		2.0		
		I_F = 60A, T_J = 150°C			2.0	

DYNAMIC CHARACTERISTICS

Symbol	Characteristic		MIN	TYP	MAX	UNIT
t_{rr1}	Reverse Recovery Time, I_F = 1.0A, di_F/dt = -15A/µs, V_R = 30V, T_J = 25°C			70	85	ns
t_{rr2}	Reverse Recovery Time	T_J = 25°C		70		
t_{rr3}	I_F = 60A, di_F/dt = -480A/µs, V_R = 650V	T_J = 100°C		130		
t_{fr1}	Forward Recovery Time	T_J = 25°C		170		
t_{fr2}	I_F = 60A, di_F/dt = 480A/µs, V_R = 650V	T_J = 100°C		170		
I_{RRM1}	Reverse Recovery Current	T_J = 25°C		18	30	Amps
I_{RRM2}	I_F = 60A, di_F/dt = -480A/µs, V_R = 650V	T_J = 100°C		29	40	
Q_{rr1}	Recovery Charge	T_J = 25°C		630		nC
Q_{rr2}	I_F = 60A, di_F/dt = -480A/µs, V_R = 650V	T_J = 100°C		1820		
V_{fr1}	Forward Recovery Voltage	T_J = 25°C		12		Volts
V_{fr2}	I_F = 60A, di_F/dt = 480A/µs, V_R = 650V	T_J = 100°C		12		
diM/dt	Rate of Fall of Recovery Current	T_J = 25°C		900		A/µs
	I_F = 60A, di_F/dt = -480A/µs, V_R = 650V (See Figure 33)	T_J = 100°C		600		

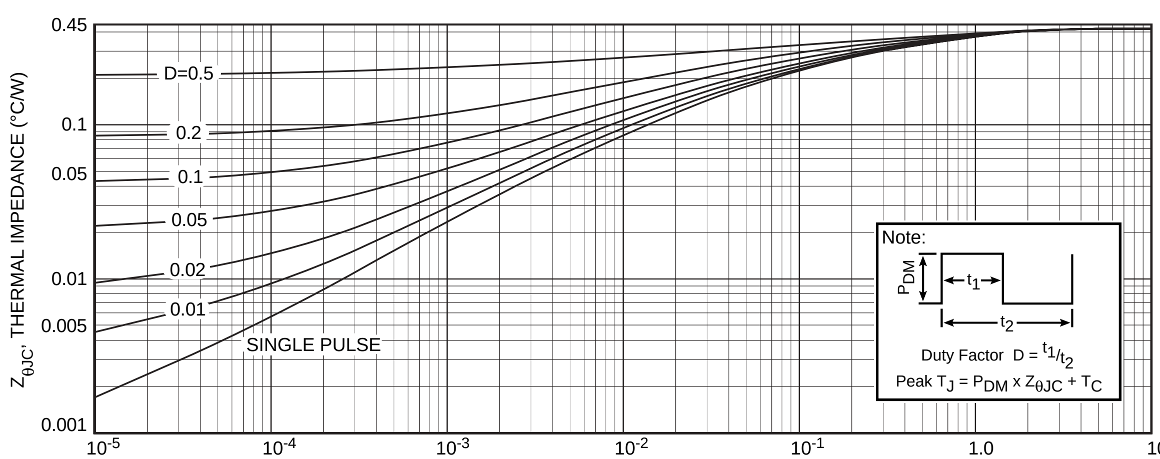


FIGURE 1, MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs PULSE DURATION

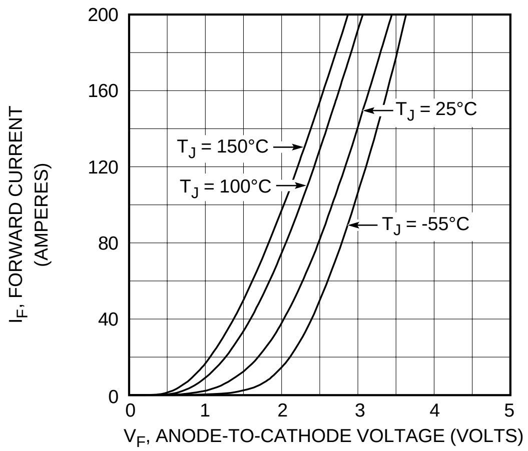


Figure 2, Forward Voltage Drop vs Forward Current

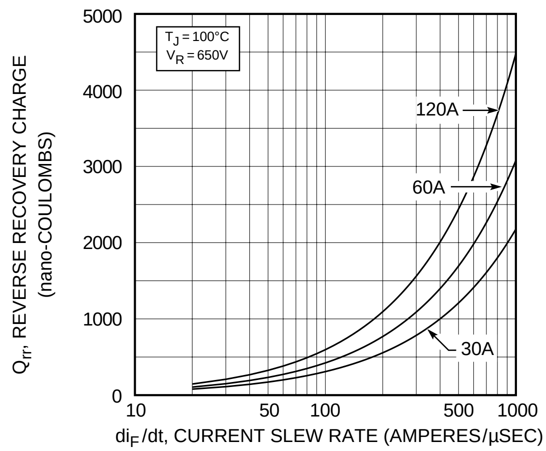


Figure 3, Reverse Recovery Charge vs Current Slew Rate

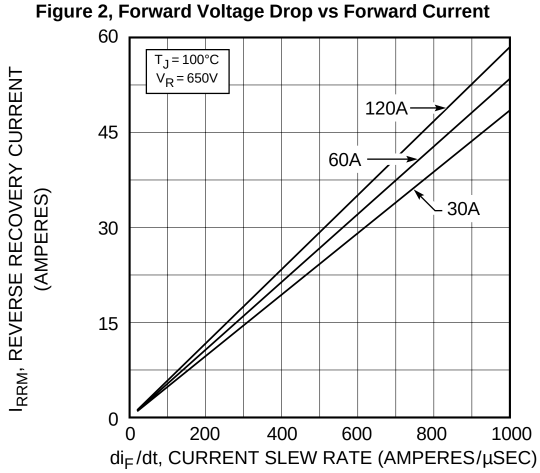


Figure 4, Reverse Recovery Current vs Current Slew Rate

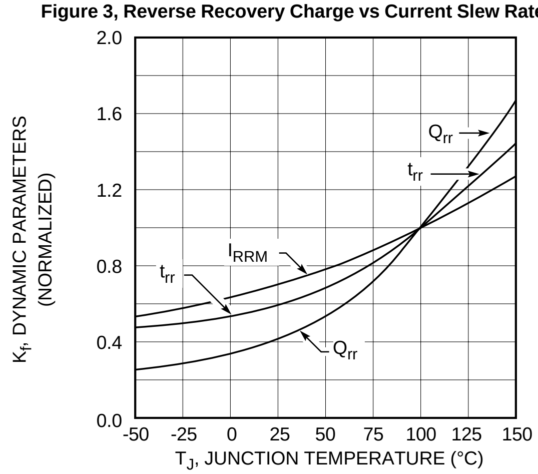


Figure 5, Dynamic Parameters vs Junction Temperature

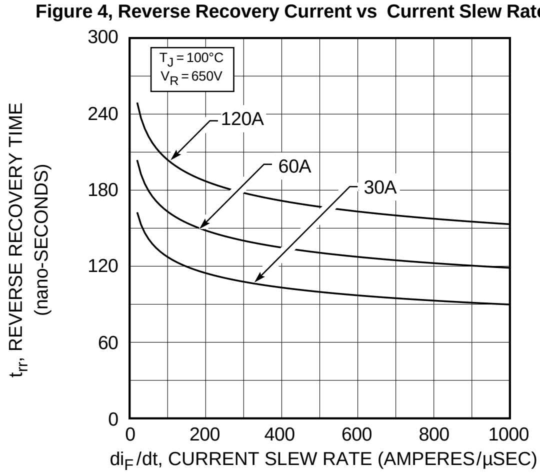


Figure 6, Reverse Recovery Time vs Current Slew Rate

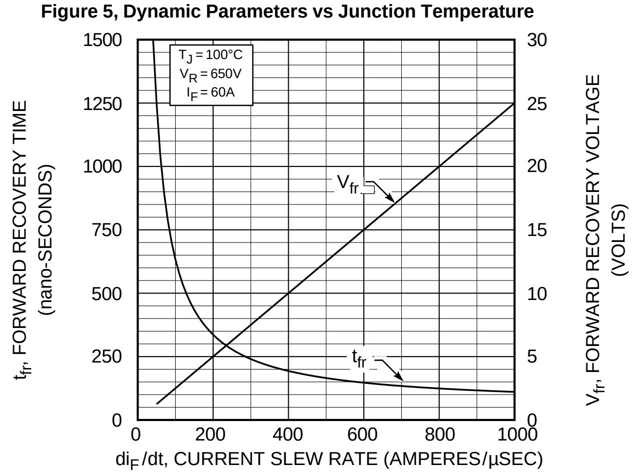


Figure 7, Forward Recovery Voltage/Time vs Current Slew Rate

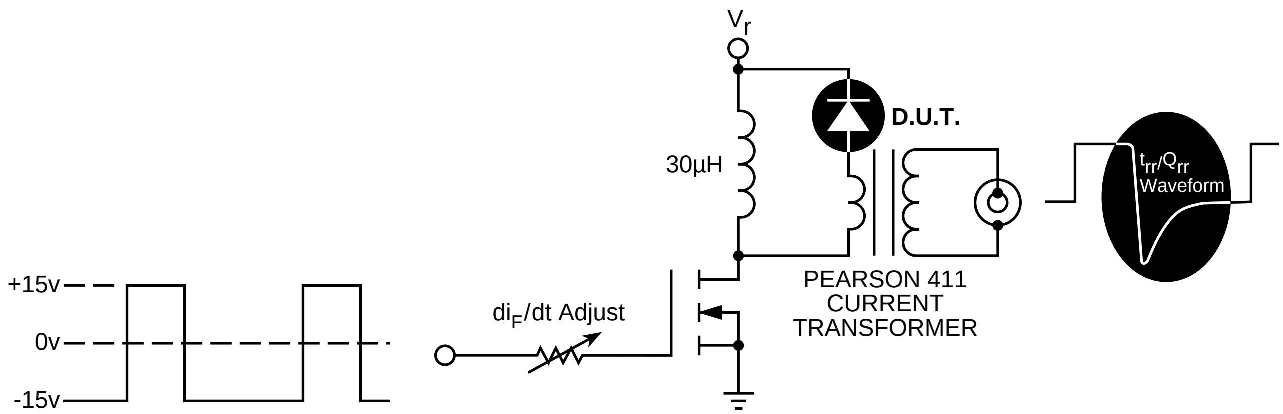


Figure 32, Diode Reverse Recovery Test Circuit and Wave Forms

1. I_F - Forward Conduction Current
2. di_F/dt - Current Slew Rate, Rate of Forward Current Change Through Zero Crossing.
3. I_{RRM} - Peak Reverse Recovery Current.
4. t_{rr} - Reverse Recovery Time Measured from Point of I_F Current Falling Through Zero to a Tangent Line {6 diM/dt} Extrapolated Through Zero Defined by 0.75 and 0.50 I_{RRM}.
5. Q_{rr} - Area Under the Curve Defined by I_{RRM} and t_{rr}.
6. diM/dt - Maximum Rate of Current Change During the Trailing Portion of t_{rr}.

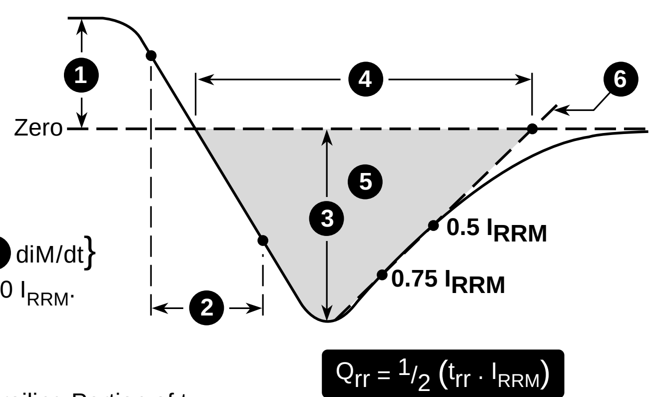
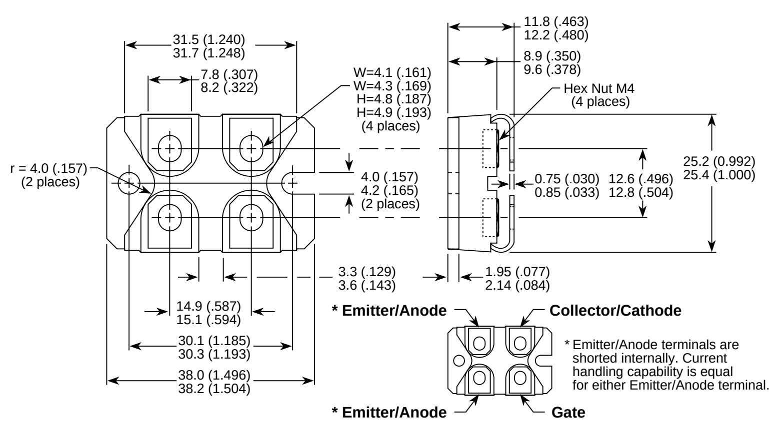


Figure 33, Diode Reverse Recovery Wave Forms and Definitions

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches)

APT's devices are covered by one or more of the following U.S.patents:						
	4,895,810	5,045,903	5,089,434	5,182,234	5,019,522	5,262,336
	5,256,583	4,748,103	5,283,202	5,231,474	5,434,095	5,528,058