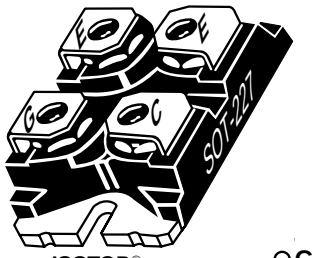
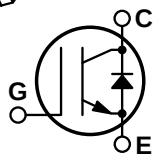
APT60GT60JRD

600V 93A

Thunderbolt IGBT™



ISOTOP®



The Thunderbolt IGBT™ is a new generation of high voltage power IGBTs. Using Non-Punch Through Technology the Thunderbolt IGBT™ offers superior ruggedness and ultrafast switching speed.

- **Low Forward Voltage Drop**
- **High Freq. Switching to 150KHz**
- **Low Tail Current**
- **Ultra Low Leakage Current**
- **Avalanche Rated**
- **RBSOA and SCSOA Rated**

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

Symbol	Parameter	APT60GT60JRD	UNIT
V_{CES}	Collector-Emitter Voltage	600	Volts
V_{CGR}	Collector-Gate Voltage (R_{GE} = 20KΩ)	600	
V_{GE}	Gate Emitter Voltage	±20	
I_{C1}	Continuous Collector Current @ T_C = 25°C	93	Amps
I_{C2}	Continuous Collector Current @ T_C = 95°C	60	
I_{CM}	Pulsed Collector Current ① @ T_C = 25°C	360	
I_{LM}	RBSOA Clamped Inductive Load Current R_G = 11Ω T_C = 25°C	360	
P_D	Total Power Dissipation	378	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 = 700μA, T_j = 25°C)	3	4	5	Volts
V_{CE}(ON)	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = I_{C2}, T_j = 25°C)		2.0	2.5	
	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = I_{C2}, T_j = 125°C)			2.8	
I_{CES}	Collector Cut-off Current (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 25°C)			330	μA
	Collector Cut-off Current (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 150°C)			2500	
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.

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

USA 405 S.W. Columbia Street Bend, Oregon 97702-1035 Phone: (541) 382-8028 FAX: (541) 388-0364

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052-6260 Rev E 7-2002

DYNAMIC CHARACTERISTICS

APT60GT60JRD

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	**Capacitance** V_{GE} = 0V, V_{CE} = 25V, f = 1 MHz		3125	3590	pF
C_{oes}	Output Capacitance			310	450	
C_{res}	Reverse Transfer Capacitance			180	310	
Q_g	Total Gate Charge ③	**Gate Charge** V_{GE} = 15V, V_{CC} = 0.5V_{CES}, I_C = I_{C2}		257	410	nC
Q_{ge}	Gate-Emitter Charge			19	30	
Q_{gc}	Gate-Collector ("Miller") Charge			120	180	
t_d(on)	Turn-on Delay Time	**Resistive Switching (25°C)** V_{GE} = 15V, V_{CC} = 0.5V_{CES}, I_C = I_{C2}, R_G = 5Ω		20	40	ns
t_r	Rise Time			95	190	
t_d(off)	Turn-off Delay Time			315	470	
t_f	Fall Time			245	490	
t_d(on)	Turn-on Delay Time	**Inductive Switching (150°C)** V_{CLAMP}(Peak) = 0.66V_{CES}, V_{GE} = 15V, I_C = I_{C2}, R_G = 5Ω, T_J = +150°C		25	50	ns
t_r	Rise Time			59	120	
t_d(off)	Turn-off Delay Time			430	650	
t_f	Fall Time			65	130	
E_{on}	Turn-on Switching Energy			1.6	3.2	mJ
E_{off}	Turn-off Switching Energy			2.4	4.8	
E_{ts}	Total Switching Losses			4.0	8.0	
t_d(on)	Turn-on Delay Time	**Inductive Switching (25°C)** V_{CLAMP}(Peak) = 0.66V_{CES}, V_{GE} = 15V, I_C = I_{C2}, R_G = 5Ω, T_J = +25°C		26	50	ns
t_r	Rise Time			63	125	
t_d(off)	Turn-off Delay Time			395	590	
t_f	Fall Time			68	140	
E_{ts}	Total Switching Losses			3.4	7.0	mJ
gfe	Forward Transconductance	V_{CE} = 20V, I_C = I_{C2}	4			S

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\Theta JC}$	Junction to Case (IGBT)			0.33	°C/W
	Junction to Case (FRED)			0.90	
$R_{\Theta JA}$	Junction to Ambient			40	
W_T	Package Weight		1.03		oz
			29.2		gm
Torque	Mounting Torque (Mounting = 8-32 or 4mm Machine and Terminals = 4mm Machine)			10	lb•in
				1.5	N•m

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

② I_C = I_{C2}, R_{GE} = 25Ω, L = 100µH, T_j = 25°C

③ See MIL-STD-750 Method 3471

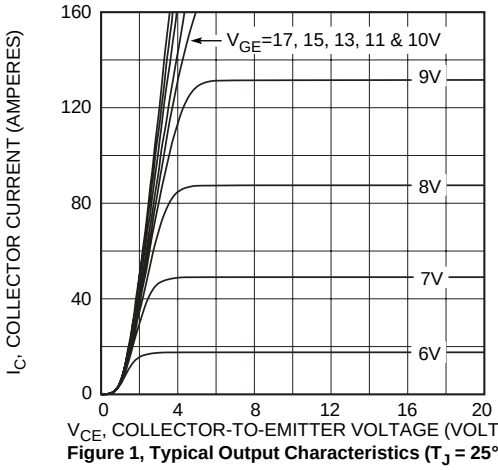


Figure 1, Typical Output Characteristics (T_J = 25°C)

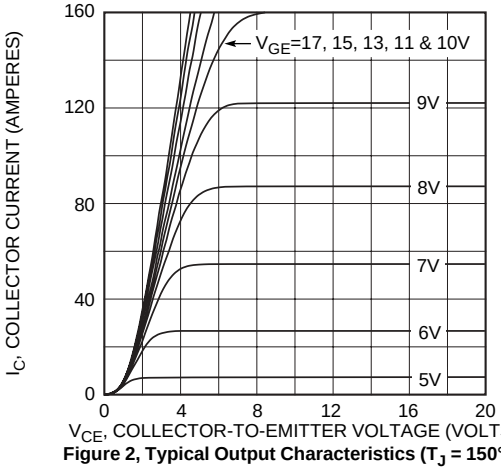


Figure 2, Typical Output Characteristics (T_J = 150°C)

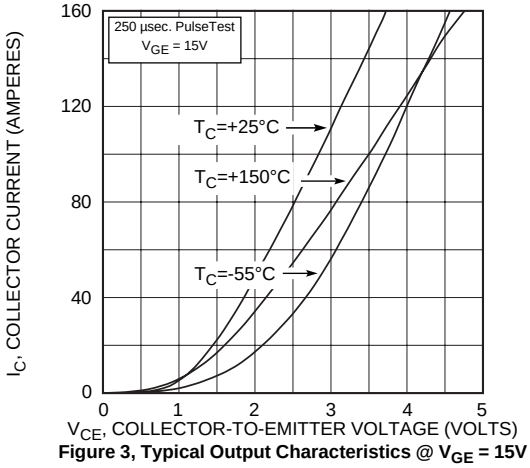


Figure 3, Typical Output Characteristics @ V_{GE} = 15V

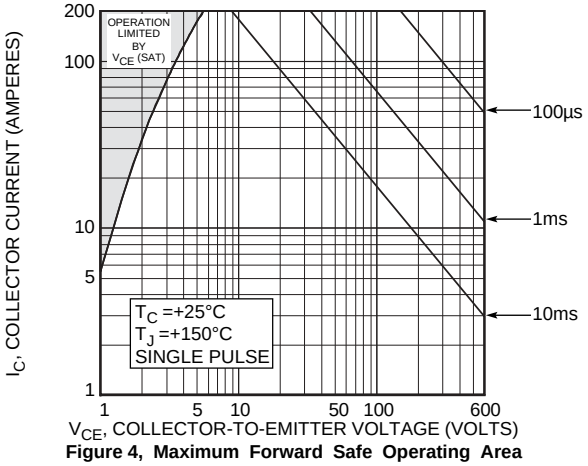


Figure 4, Maximum Forward Safe Operating Area

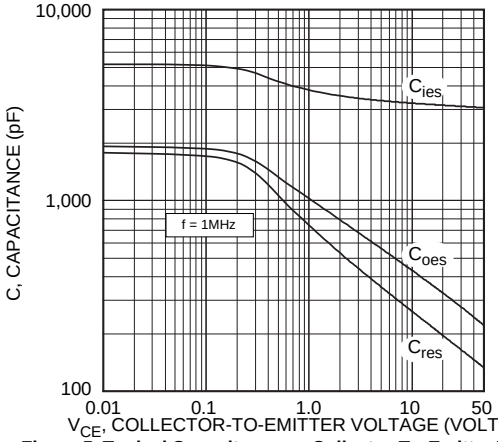


Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

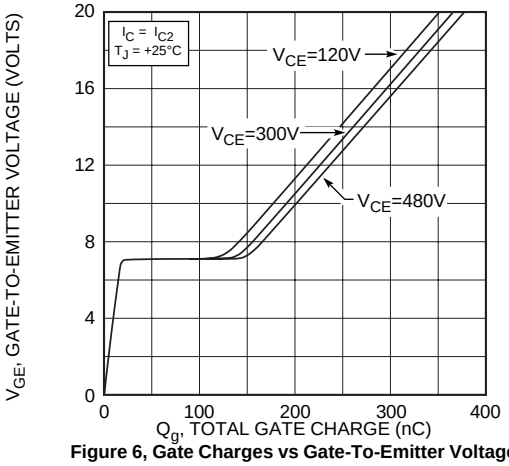


Figure 6, Gate Charges vs Gate-To-Emitter Voltage

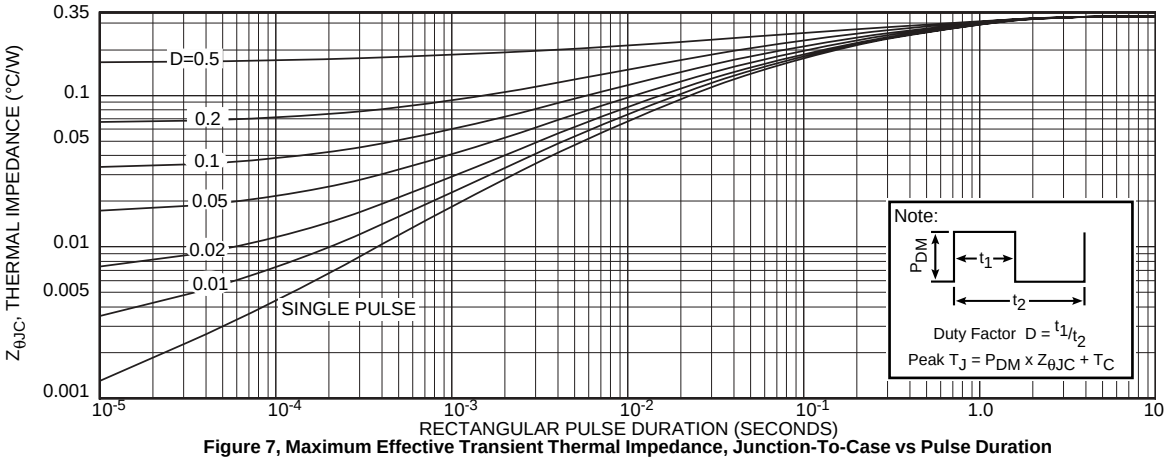


Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

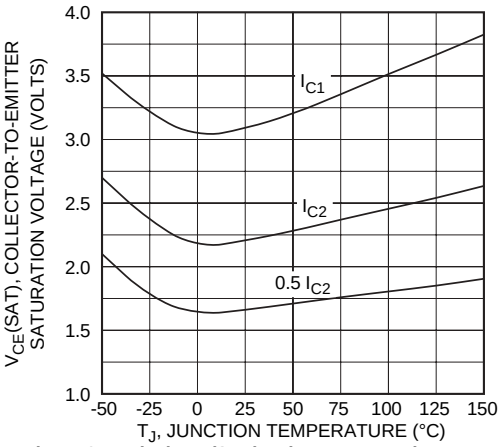


Figure 8, Typical V_{CE}(SAT) Voltage vs Junction Temperature

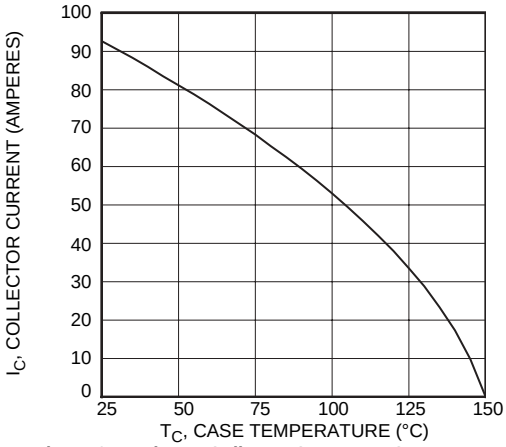


Figure 9, Maximum Collector Current vs Case Temperature

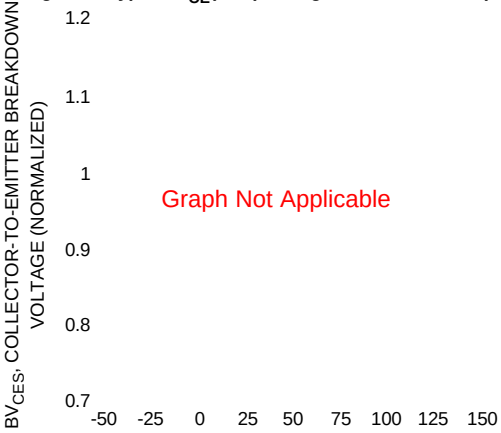


Figure 10, Breakdown Voltage vs Junction Temperature

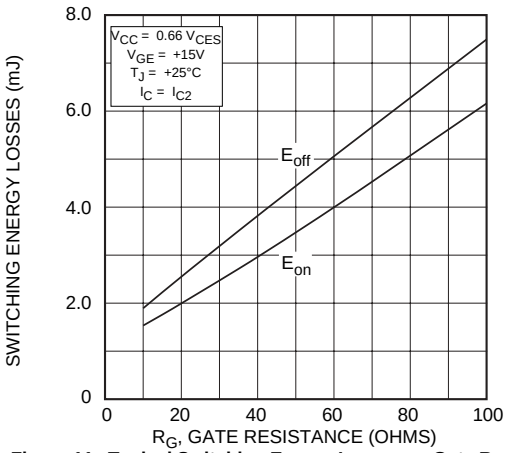


Figure 11, Typical Switching Energy Losses vs Gate Resistance

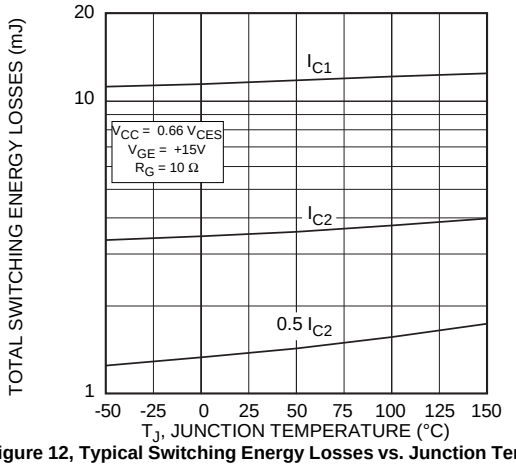


Figure 12, Typical Switching Energy Losses vs. Junction Temperature

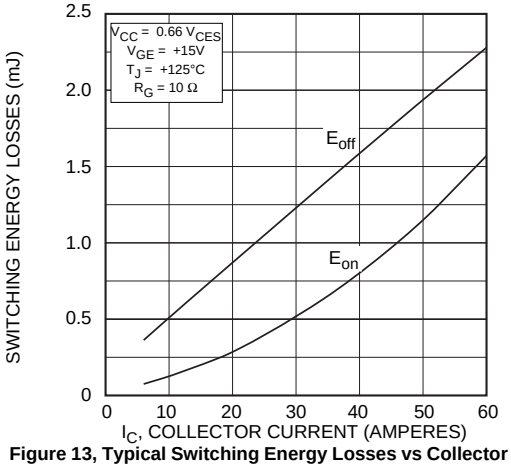


Figure 13, Typical Switching Energy Losses vs Collector Current

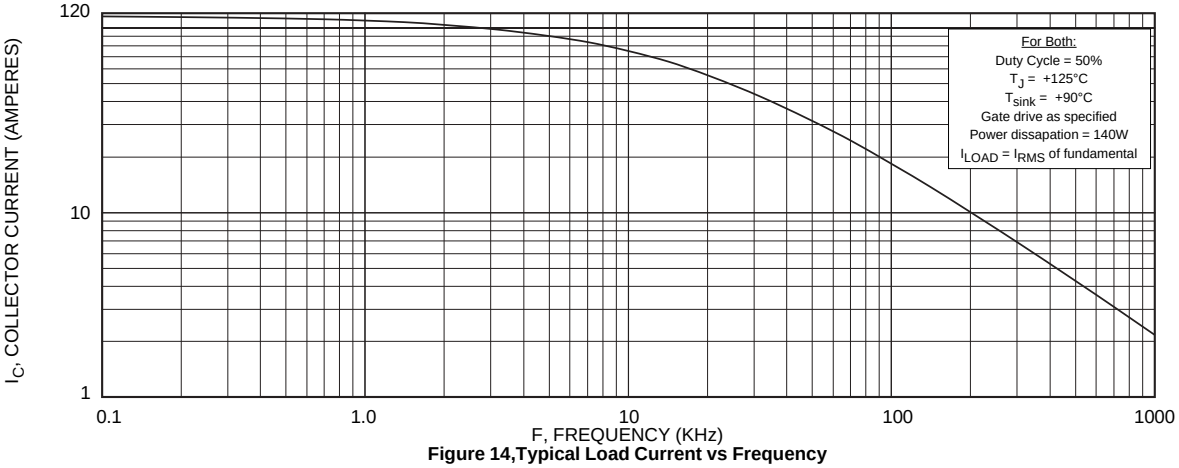


Figure 14,Typical Load Current vs Frequency

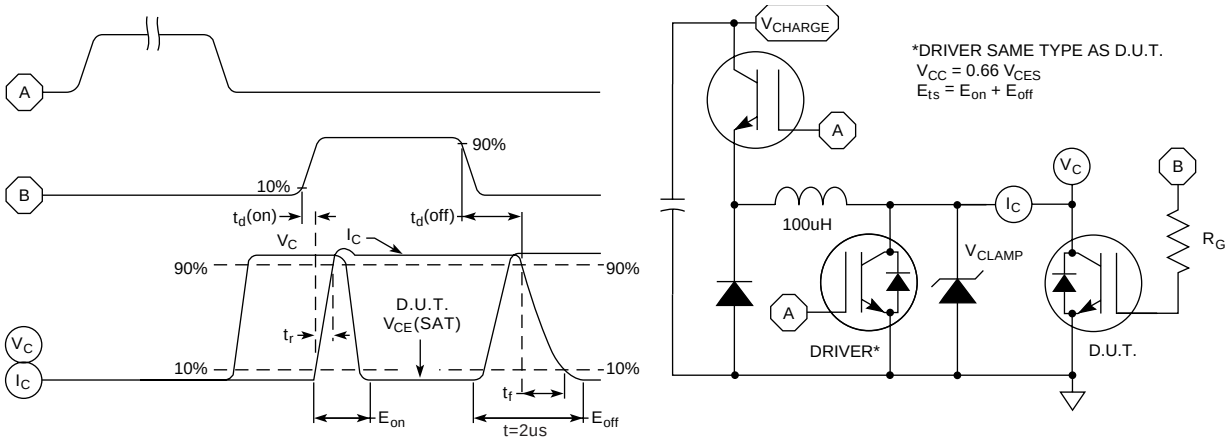


Figure 15, Switching Loss Test Circuit and Waveforms

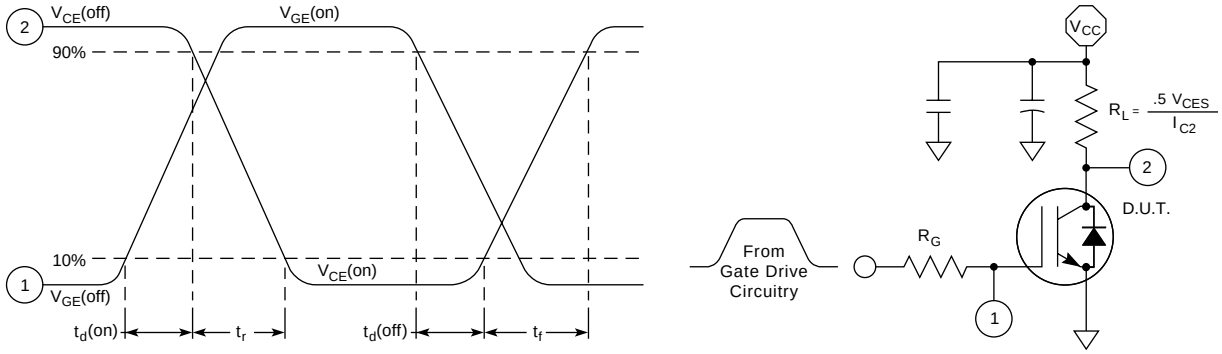


Figure 16, Resistive Switching Time Test Circuit and Waveforms

MAXIMUM RATINGS (FRED)

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

Symbol	Characteristic	60GT60JRD	UNIT
IF_{AV}	Maximum Average Forward Current (T_C = 100°C, Duty Cycle = 0.5)	60	Amps
IF_{RMS}	RMS Forward Current	100	
I_{FSM}	Non-Repetive Forward Surge Current (T_J = 45°C, 8.3 ms)	600	

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Maximum Forward Voltage	I_F = 60A			1.8	Volts
		I_F = 120A		1.75		
		I_F = 60A, T_J = 150°C			1.5	
L_S	Series Inductance (Lead to Lead 5mm from Base)			10		nH

DYNAMIC CHARACTERISTICS (FRED)

APT60GT60JRD

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			55	70	ns
t_{rr2}	Reverse Recovery Time	T_J = 25°C		70		
t_{rr3}	I_F = 60A, di_F/dt = -480A/µs, V_R = 350V	T_J = 100°C		90		
t_{fr1}	Forward Recovery Time	T_J = 25°C		160		
t_{fr2}	I_F = 60A, di_F/dt = 480A/µs, V_R = 350V	T_J = 100°C		160		
I_{RRM1}	Reverse Recovery Current	T_J = 25°C		10	17	Amps
I_{RRM2}	I_F = 60A, di_F/dt = -480A/µs, V_R = 350V	T_J = 100°C		20	30	
Q_{rr1}	Recovery Charge	T_J = 25°C		350		nC
Q_{rr2}	I_F = 60A, di_F/dt = -480A/µs, V_R = 350V	T_J = 100°C		900		
V_{fr1}	Forward Recovery Voltage	T_J = 25°C		6		Volts
V_{fr2}	I_F = 60A, di_F/dt = 480A/µs, V_R = 350V	T_J = 100°C		6		
diM/dt	Rate of Fall of Recovery Current	T_J = 25°C		800		A/µs
	I_F = 60A, di_F/dt = -480A/µs, V_R = 350V (See Figure 18)	T_J = 100°C		500		

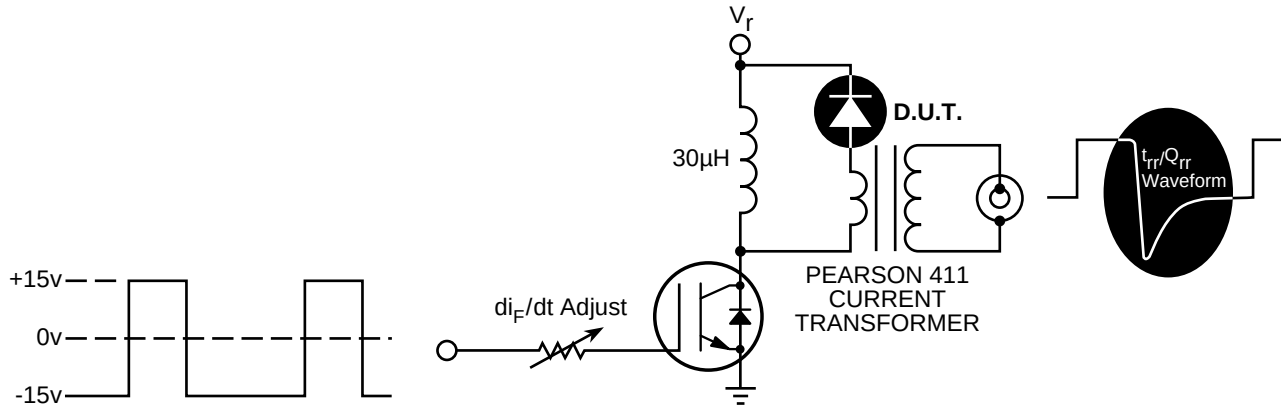
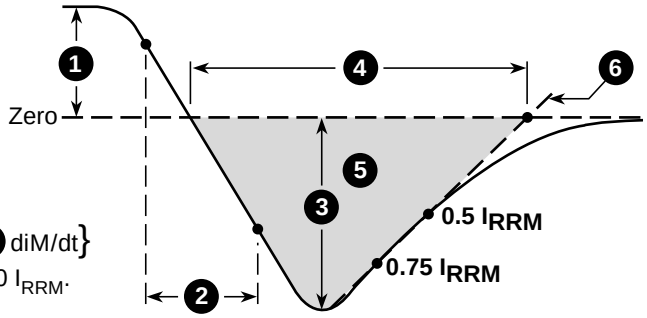


Figure 17, Diode Reverse Recovery Test Circuit and Waveforms

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}.



$Q_{rr} = {}^1/_2 (t_{rr} \cdot I_{RRM})$

Figure 18. Diode Reverse Recovery Waveform and Definitions

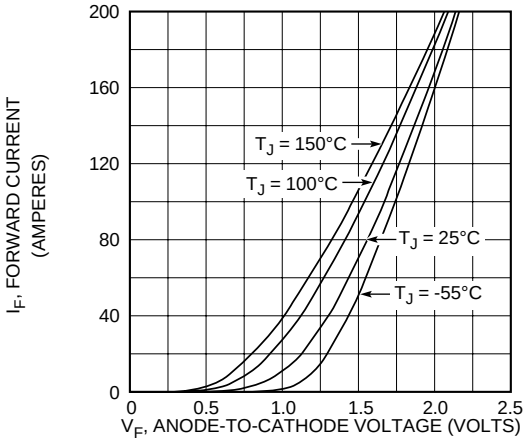


Figure 19, Forward Voltage Drop vs Forward Current

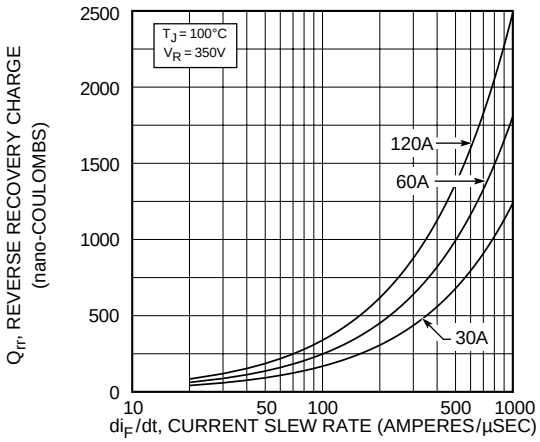


Figure 20, Reverse Recovery Charge vs Current Slew Rate

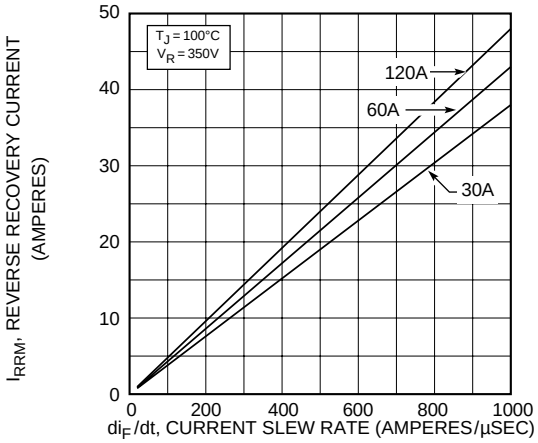


Figure 21, Reverse Recovery Current vs Current Slew Rate

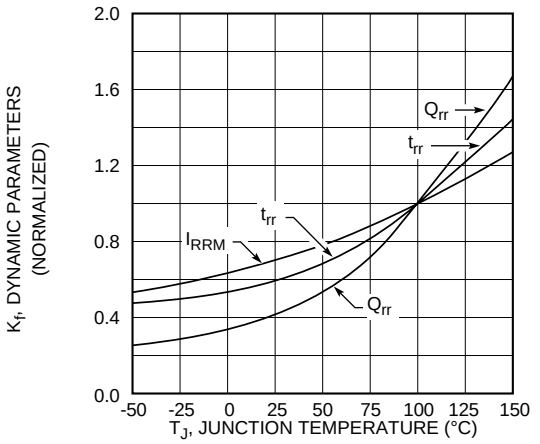


Figure 22, Dynamic Parameters vs Junction Temperature

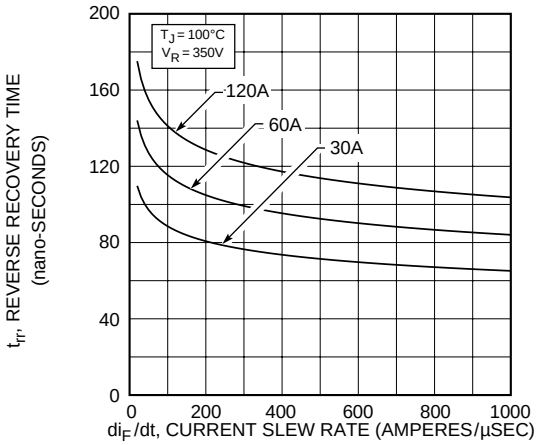


Figure 23, Reverse Recovery Time vs Current Slew Rate

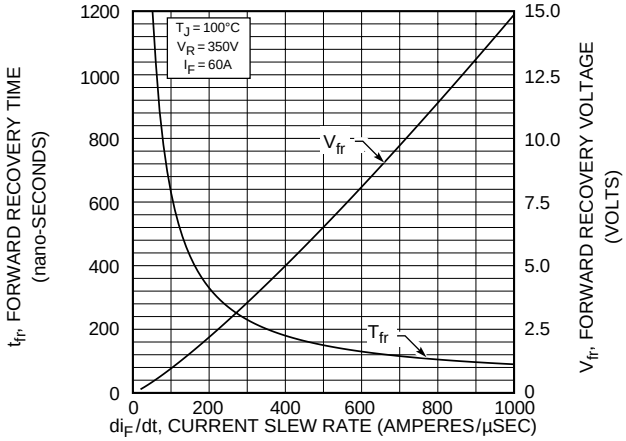


Figure 24, Forward Recovery Voltage/Time vs Current Slew Rate

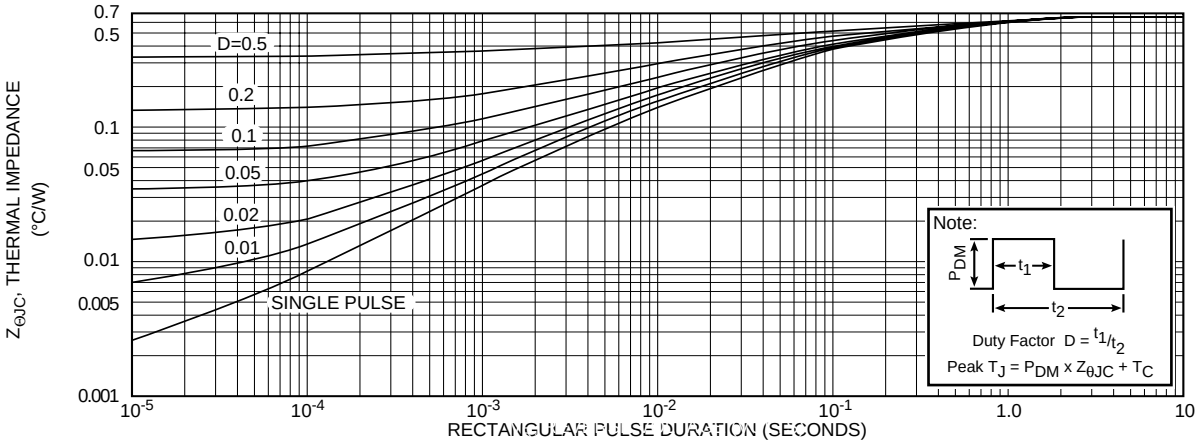
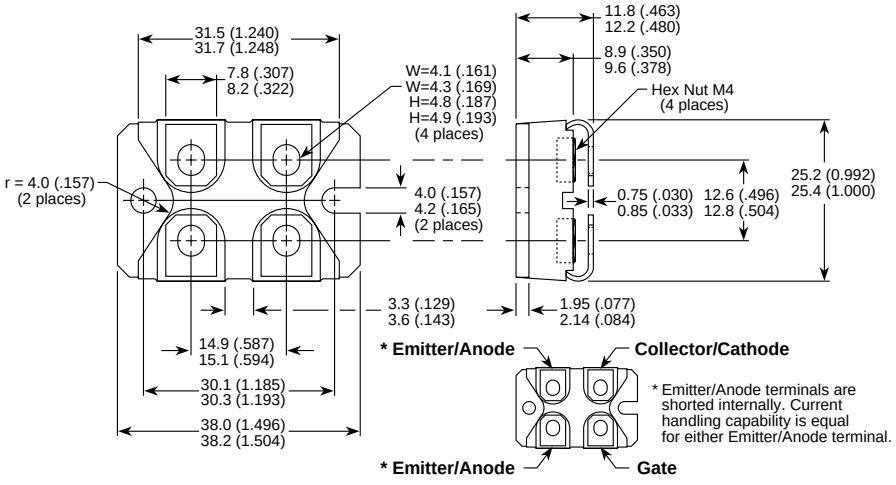


Figure 25, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches)