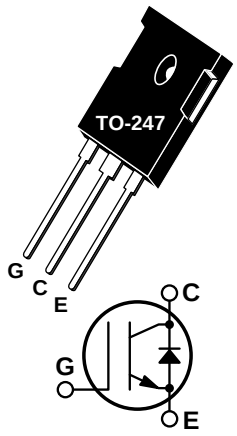
APT15GT60BRD

600V 30A

Thunderbolt IGBT™ & FRED



The Thunderbolt IGBT™ is a new generation of high voltage power IGBTs. Using Non-Punch Through Technology the Thunderbolt IGBT™ combined with an APT free-wheeling ultraFast Recovery Epitaxial Diode (FRED) offers superior ruggedness and ultrafast switching speed.

- **Low Forward Voltage Drop**
- **High Freq. Switching to 150KHz**
- **Low Tail Current**
- **Ultra Low Leakage Current**
- **RBSOA and SCSOA Rated**
- **Ultrafast Soft Recovery Antiparallel Diode**

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

Symbol	Parameter	APT15GT60BRD	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	30	Amps
I_{C2}	Continuous Collector Current @ T_C = 105°C	15	
I_{CM}	Pulsed Collector Current ① @ T_C = 25°C	60	
I_{LM}	RBSOA Clamped Inductive Load Current R_G = 11Ω T_C = 110°C	30	
P_D	Total Power Dissipation	125	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
BV_{CES}	Collector-Emitter Breakdown Voltage (V_{GE} = 0V, I_C = 0.5mA)	600			Volts
$V_{GE}(TH)$	Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 700µA, T_j = 25°C)	3	4	5	
$V_{CE}(ON)$	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = I_{C2}, T_j = 25°C)	1.6	2.0	2.5	
	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = I_{C2}, T_j = 150°C)			2.8	
I_{CES}	Collector Cut-off Current ② (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 25°C)			200	µA
	Collector Cut-off Current ② (V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 150°C)			1500	
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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DYNAMIC CHARACTERISTICS

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	**Capacitance** V_{GE} = 0V, V_{CE} = 25V, f = 1 MHz		810	930	pF
C_{oes}	Output Capacitance			130	190	
C_{res}	Reverse Transfer Capacitance			52	90	
Q_g	Total Gate Charge ③	**Gate Charge** V_{GE} = 15V, V_{CC} = 0.5V_{CES}, I_C = I_{C2}		74	110	nC
Q_{ge}	Gate-Emitter Charge			5.2	10	
Q_{gc}	Gate-Collector ("Miller") Charge			34	50	
$t_d(on)$	Turn-on Delay Time	**Resistive Switching (25°C)** V_{GE} = 15V, V_{CC} = 0.5V_{CES}, I_C = I_{C2}, R_G = 10Ω		9	20	ns
t_r	Rise Time			27	50	
$t_d(off)$	Turn-off Delay Time			92	140	
t_f	Fall Time			123	250	
$t_d(on)$	Turn-on Delay Time	**Inductive Switching (150°C)** V_{CLAMP}(Peak) = 0.66V_{CES}, V_{GE} = 15V, I_C = I_{C2}, R_G = 10Ω, T_J = +150°C		11	21	ns
t_r	Rise Time			13	30	
$t_d(off)$	Turn-off Delay Time			110	170	
t_f	Fall Time			148	300	
E_{on}	Turn-on Switching Energy ④			160	320	µJ
E_{off}	Turn-off Switching Energy			465	930	
E_{ts}	Total Switching Losses ④			625	1250	
$t_d(on)$	Turn-on Delay Time	**Inductive Switching (25°C)** V_{CLAMP}(Peak) = 0.66V_{CES}, V_{GE} = 15V, I_C = I_{C2}, R_G = 10Ω, T_J = +25°C		11	20	ns
t_r	Rise Time			13	30	
$t_d(off)$	Turn-off Delay Time			91	140	
t_f	Fall Time			67	130	
E_{ts}	Total Switching Losses ④			395	790	µJ
gfe	Forward Transconductance	V_{CE} = 20V, I_C = I_{C2}	3			S

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\Theta JC}$	Junction to Case (IGBT)			1.0	°C/W
	Junction to Case (FRED)			2.0	
$R_{\Theta JA}$	Junction to Ambient			40	
W_T	Package Weight		0.22		oz
			6.1		gm
Torque	Mounting Torque (Mounting = 8-32 or 4mm Machine and Terminals = 4mm Machine)			10	lb•in
				1.1	N•m

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

② Leakages include the FRED and IGBT.

③ See MIL-STD-750 Method 3471

④ Switching losses include the FRED and IGBT.

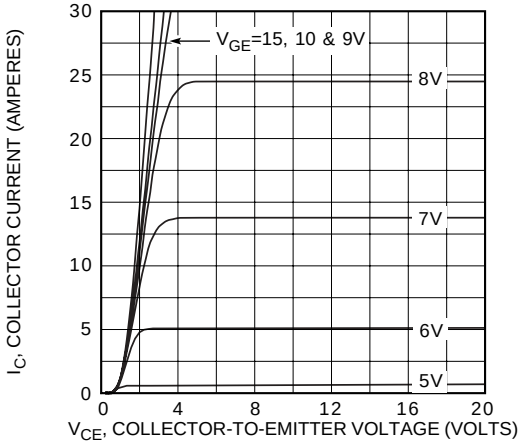


Figure 1, Typical Output Characteristics (T_J = 25°C)

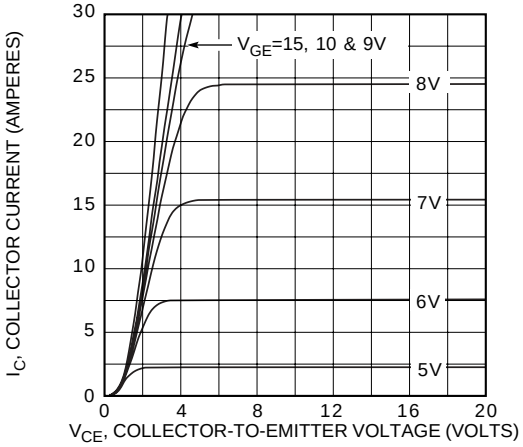


Figure 2, Typical Output Characteristics (T_J = 150°C)

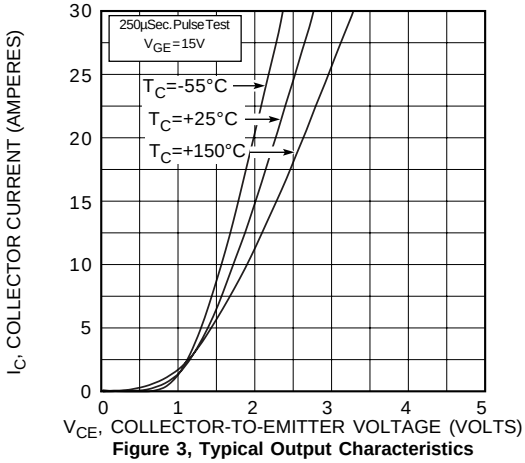


Figure 3, Typical Output Characteristics

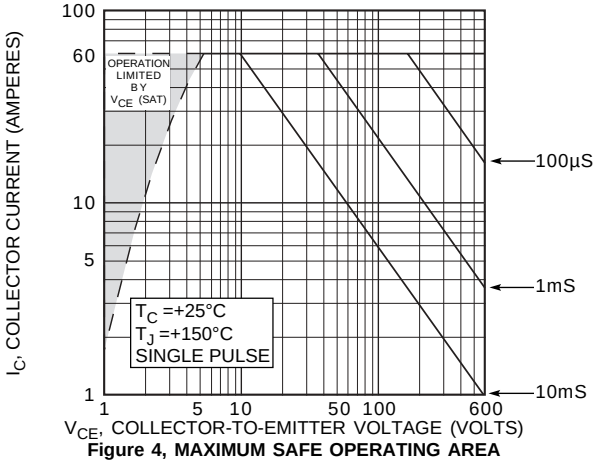


Figure 4, MAXIMUM SAFE OPERATING AREA

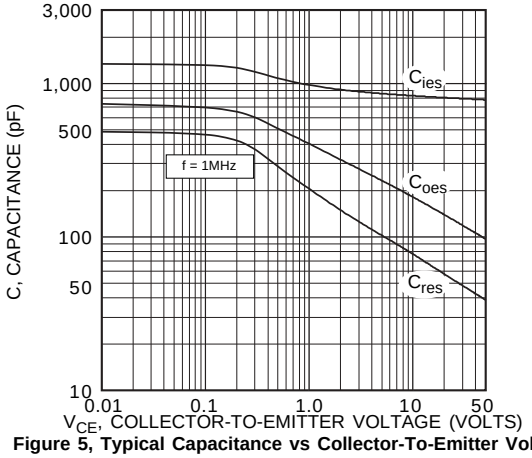


Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

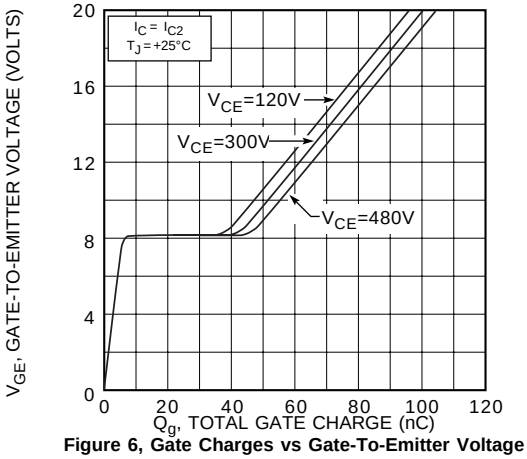


Figure 6, Gate Charges vs Gate-To-Emitter Voltage

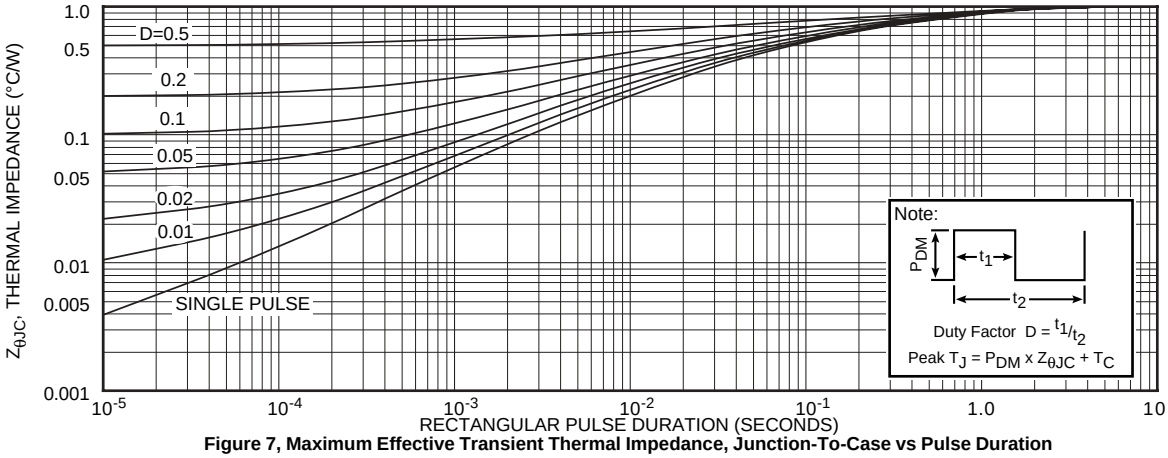


Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

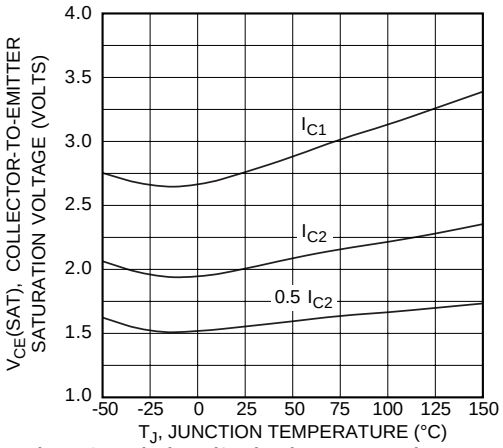


Figure 8, Typical V_{CE}(SAT) Voltage vs Junction Temperature

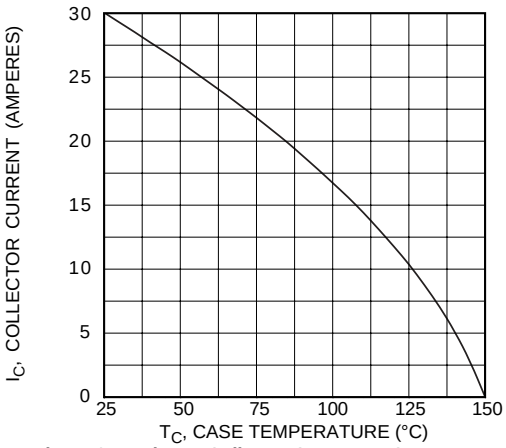


Figure 9, Maximum Collector Current vs Case Temperature

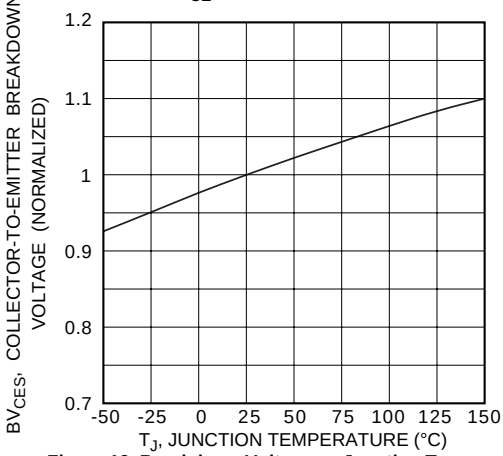


Figure 10, Breakdown Voltage vs Junction Temperature

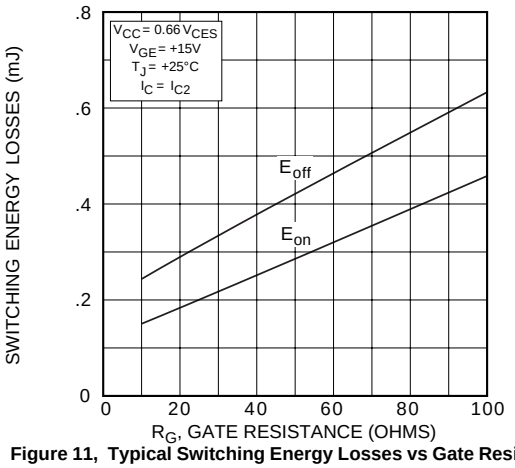


Figure 11, Typical Switching Energy Losses vs Gate Resistance

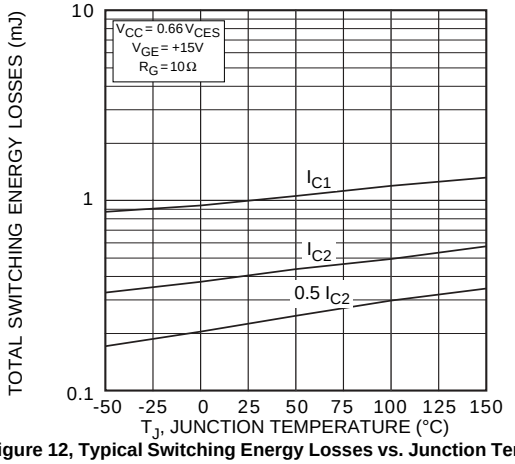


Figure 12, Typical Switching Energy Losses vs. Junction Temperature

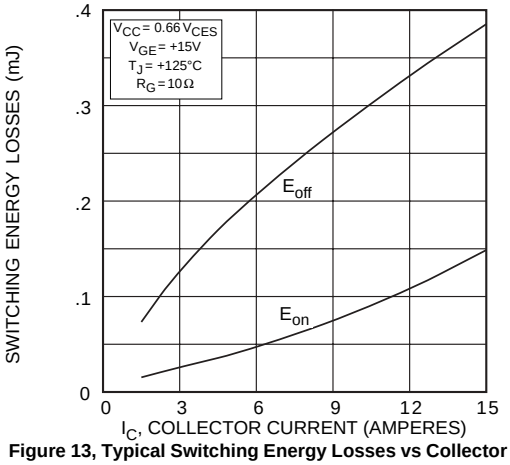


Figure 13, Typical Switching Energy Losses vs Collector Current

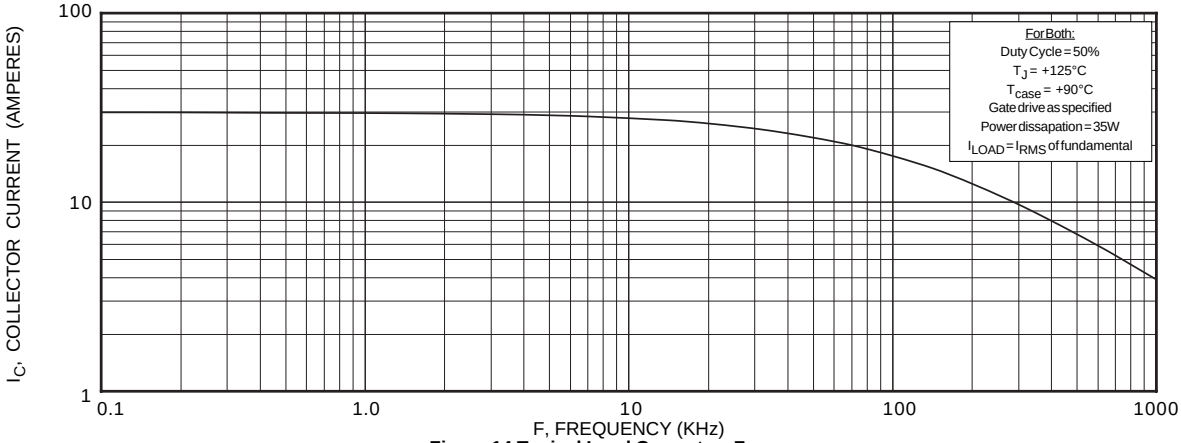


Figure 14,Typical Load Current vs Frequency

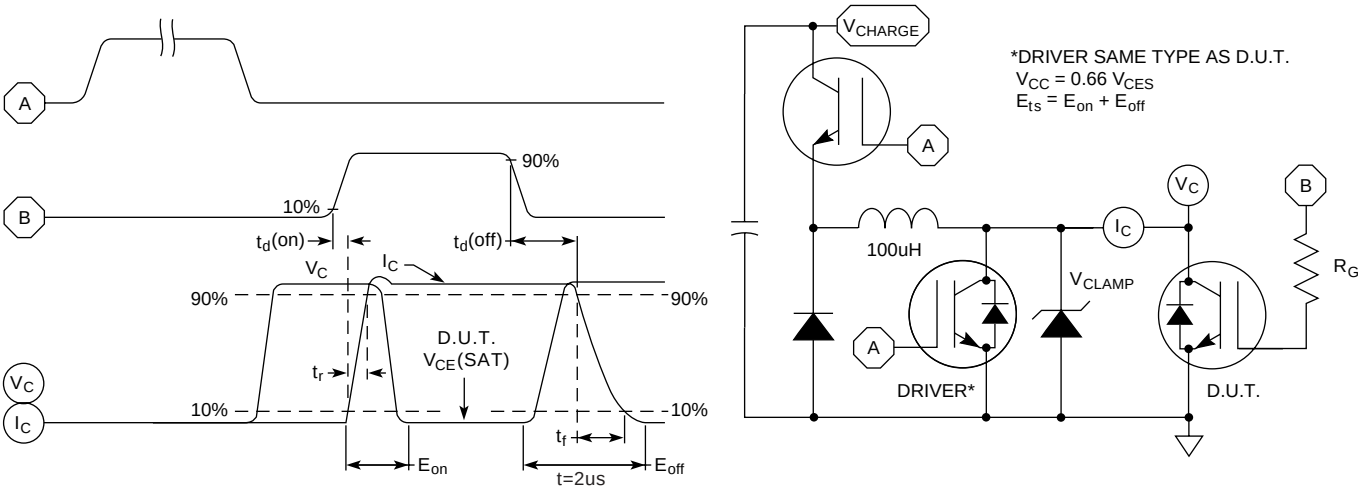


Figure 15, Switching Loss Test Circuit and Waveforms

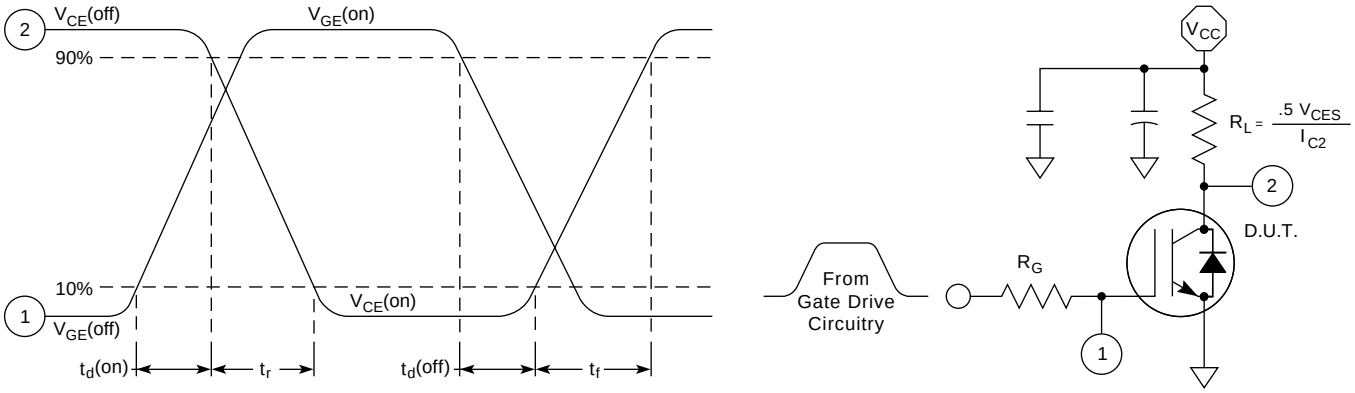


Figure 16, Resistive Switching Time Test Circuit and Waveforms

MAXIMUM RATINGS (FRED)

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

Symbol	Characteristic	15GT60BRD	UNIT
IF_{AV}	Maximum Average Forward Current (T_C = 100°C, Duty Cycle = 0.5)	15	Amps
IF_{RMS}	RMS Forward Current	25	
I_{FSM}	Non-Repetive Forward Surge Current (T_J = 45°C, 8.3 ms)	110	

STATIC ELECTRICAL CHARACTERISTICS (FRED)

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Maximum Forward Voltage	I_F = 15A			1.8	Volts
		I_F = 30A		1.6		
		I_F = 15A, T_J = 150°C			1.6	
L_S	Series Inductance (Lead to Lead 5mm from Base)			10		nH

DYNAMIC CHARACTERISTICS (FRED)

Symbol	Characteristic / Test Conditions		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			40	50	ns
t_{rr2}	Reverse Recovery Time	T_J = 25°C		40		
t_{rr3}	I_F = 15A, di_F/dt = -240A/µs, V_R = 350V	T_J = 100°C		80		
t_{fr1}	Forward Recovery Time	T_J = 25°C		170		
t_{fr2}	I_F = 15A, di_F/dt = 240A/µs, V_R = 350V	T_J = 100°C		170		
I_{RRM1}	Reverse Recovery Current	T_J = 25°C		2.5	5	Amps
I_{RRM2}	I_F = 15A, di_F/dt = -240A/µs, V_R = 350V	T_J = 100°C		3	6	
Q_{rr1}	Recovery Charge	T_J = 25°C		50		nC
Q_{rr2}	I_F = 15A, di_F/dt = -240A/µs, V_R = 350V	T_J = 100°C		120		
V_{fr1}	Forward Recovery Voltage	T_J = 25°C		2.2		Volts
V_{fr2}	I_F = 15A, di_F/dt = 240A/µs, V_R = 350V	T_J = 100°C		2.2		
diM/dt	Rate of Fall of Recovery Current	T_J = 25°C		200		A/µs
	I_F = 15A, di_F/dt = -240A/µs, V_R = 350V (See Figure 18)	T_J = 100°C		100		

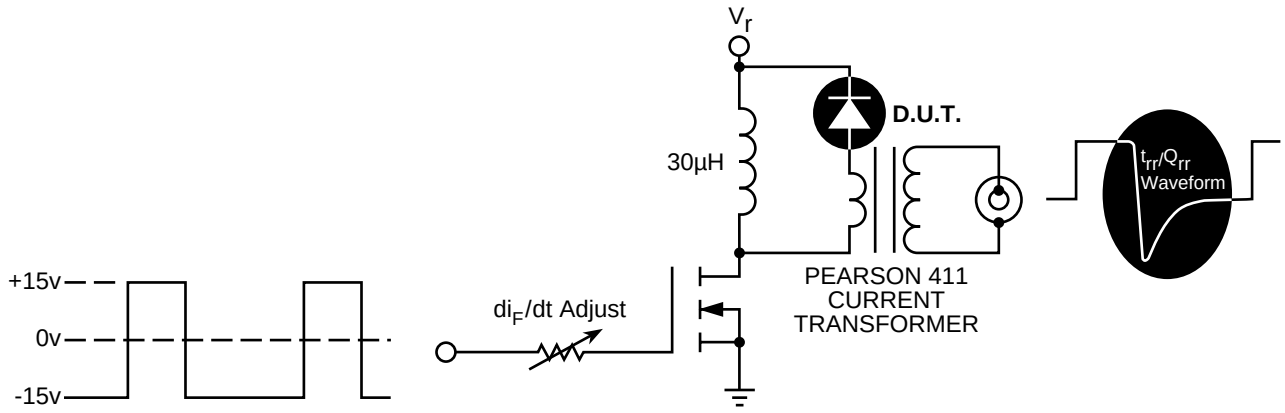


Figure 17, Diode Reverse Recovery Test Circuit and Waveforms

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}.

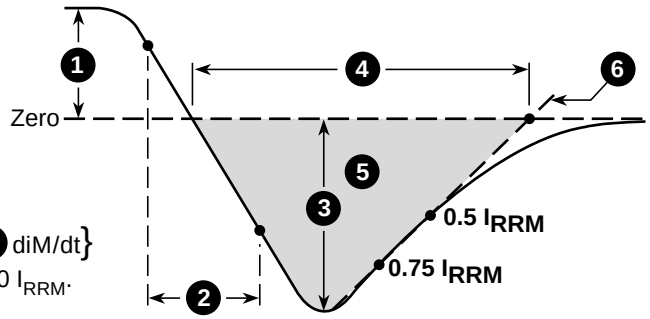


Figure 18, Diode Reverse Recovery Waveform and Definitions

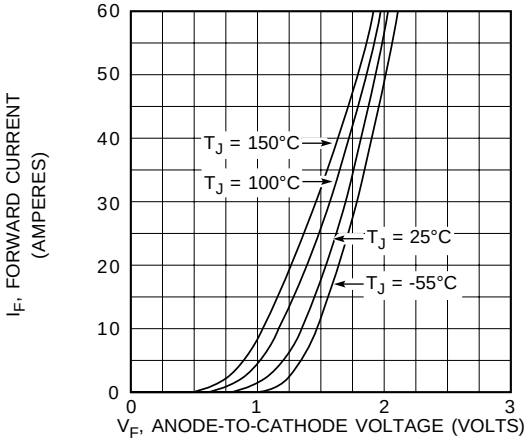


Figure 19, Forward Voltage Drop vs Forward Current

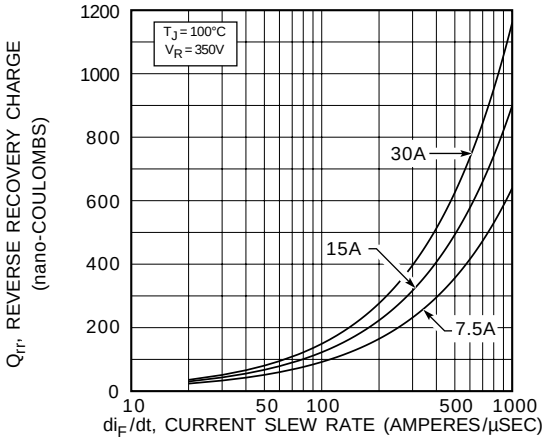


Figure 20, Reverse Recovery Charge vs Current Slew Rate

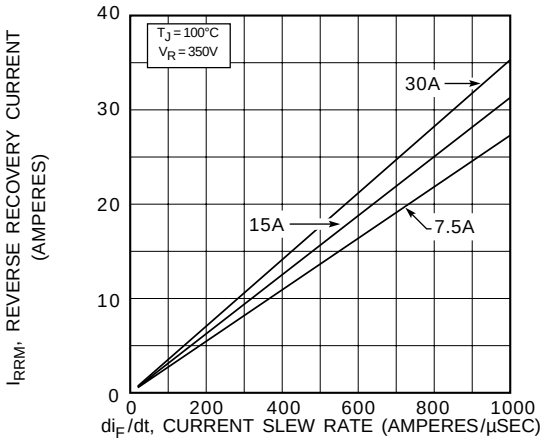


Figure 21, Reverse Recovery Current vs Current Slew Rate

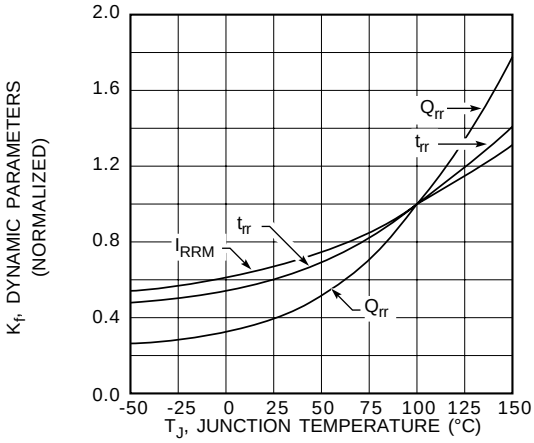


Figure 22, Dynamic Parameters vs Junction Temperature

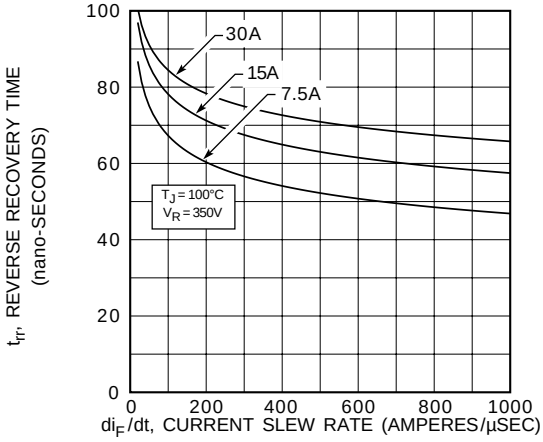


Figure 23, Reverse Recovery Time vs Current Slew Rate

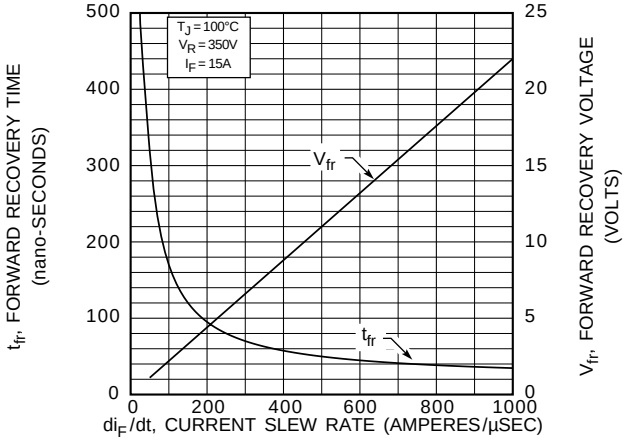


Figure 24, Forward Recovery Voltage/Time vs Current Slew Rate

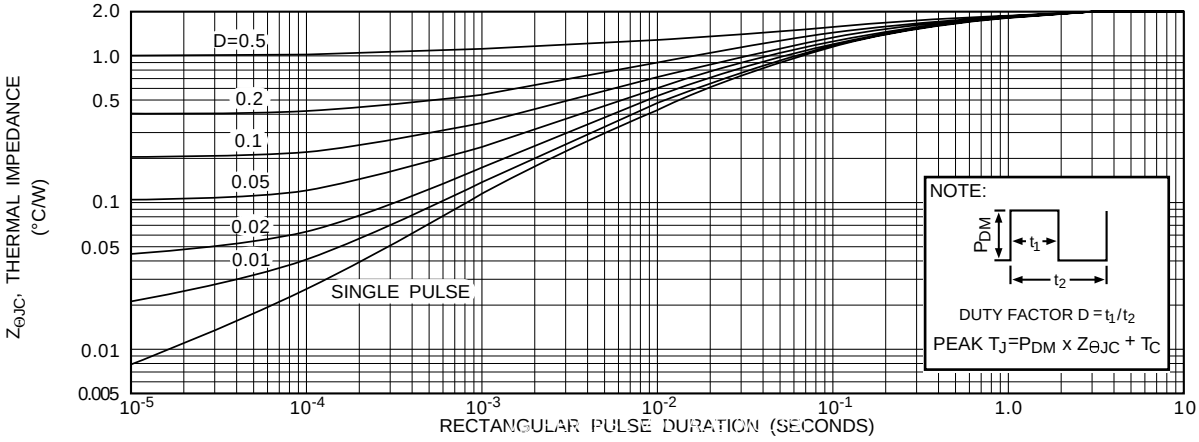
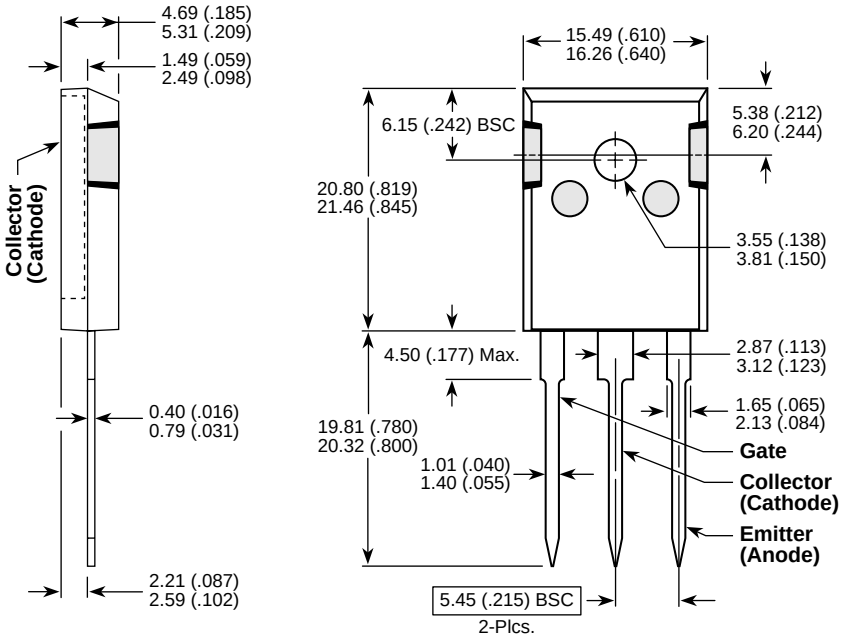


Figure 25, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

T0-247 Package Outline



Dimensions in Millimeters and (Inches)

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