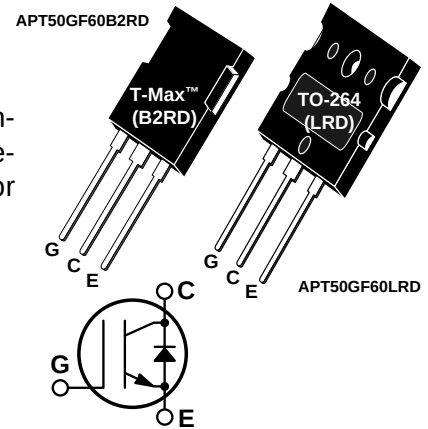


Fast IGBT & FRED

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 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
- High Freq. Switching to 20KHz
- Ultra Low Leakage Current



MAXIMUM RATINGS (IGBT)

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

Symbol	Parameter	APT50GF60B2RD/LRD	UNIT
V_{CES}	Collector-Emitter Voltage	600	Volts
V_{CGR}	Collector-Gate Voltage ($R_{GE} = 20K\Omega$)	600	
V_{GE}	Gate Emitter Voltage	± 20	
I_{C1}	Continuous Collector Current ^③ @ $T_C = 25^\circ\text{C}$	80	Amps
I_{C2}	Continuous Collector Current @ $T_C = 105^\circ\text{C}$	50	
I_{CM}	Pulsed Collector Current ^① @ $T_C = 25^\circ\text{C}$	160	
I_{LM}	RBSOA Clamped Inductive Load Current @ $R_G = 11\Omega$ $T_C = 125^\circ\text{C}$	100	
P_D	Total Power Dissipation	300	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 (IGBT)

Symbol	Characteristic / Test Conditions	MIN	TYP	MAX	UNIT
$V_{GE(TH)}$	Gate Threshold Voltage ($V_{CE} = V_{GE}$, $I_C = 700\mu\text{A}$, $T_j = 25^\circ\text{C}$)	4.5	5.5	6.5	Volts
$V_{CE(ON)}$	Collector-Emitter On Voltage ($V_{GE} = 15\text{V}$, $I_C = I_{C2}$, $T_j = 25^\circ\text{C}$)		2.1	2.7	
	Collector-Emitter On Voltage ($V_{GE} = 15\text{V}$, $I_C = I_{C2}$, $T_j = 125^\circ\text{C}$)		2.2	2.8	
I_{CES}	Collector Cut-off Current ($V_{CE} = V_{CES}$, $V_{GE} = 0\text{V}$, $T_j = 25^\circ\text{C}$)			0.75	mA
	Collector Cut-off Current ($V_{CE} = V_{CES}$, $V_{GE} = 0\text{V}$, $T_j = 125^\circ\text{C}$)			5.5	
I_{GES}	Gate-Emitter Leakage Current ($V_{GE} = \pm 20\text{V}$, $V_{CE} = 0\text{V}$)			± 100	nA



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

DYNAMIC CHARACTERISTICS (IGBT)

APT50GF60B2RD/LRD

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	Capacitance $V_{GE} = 0V$ $V_{CE} = 25V$ $f = 1\text{ MHz}$		2600	3600	pF
C_{oes}	Output Capacitance			475	710	
C_{res}	Reverse Transfer Capacitance			165	250	
Q_g	Total Gate Charge ^③	Gate Charge $V_{GE} = 15V$ $V_{CC} = 0.5V_{CES}$ $I_C = I_{C2}$		170	225	nC
Q_{ge}	Gate-Emitter Charge			25	45	
Q_{gc}	Gate-Collector ("Miller") Charge			100	140	
$t_{d(on)}$	Turn-on Delay Time	Resistive Switching (25°C) $V_{GE} = 15V$ $V_{CC} = .8V_{CES}$ $I_C = I_{C2}$ $R_G = 10\Omega$		20		ns
t_r	Rise Time			100		
$t_{d(off)}$	Turn-off Delay Time			160		
t_f	Fall Time			200		
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (150°C) $V_{CLAMP(Peak)} = 0.66V_{CES}$ $V_{GE} = 15V$ $I_C = I_{C2}$ $R_G = 10\Omega$ $T_J = +150^\circ C$		30	50	ns
t_r	Rise Time			90	135	
$t_{d(off)}$	Turn-off Delay Time			290	435	
t_f	Fall Time			170	340	
E_{on}	Turn-on Switching Energy ^④			2.2		mJ
E_{off}	Turn-off Switching Energy			2.4		
E_{ts}	Total Switching Losses ^④			4.6		
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) $V_{CLAMP(Peak)} = 0.66V_{CES}$ $V_{GE} = 15V$ $I_C = I_{C2}$ $R_G = 10\Omega$ $T_J = +25^\circ C$		30		ns
t_r	Rise Time			90		
$t_{d(off)}$	Turn-off Delay Time			260		
t_f	Fall Time			100		
E_{ts}	Total Switching Losses ^④			4.3		mJ
g_{fe}	Forward Transconductance	$V_{CE} = 20V, I_C = I_{C2}$	6			S

THERMAL AND MECHANICAL CHARACTERISTICS (IGBT and FRED)

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to Case (IGBT)			0.42	°C/W
	Junction to Case (FRED)			0.66	
$R_{\theta JA}$	Junction to Ambient			40	
W_T	Package Weight		0.22		oz
			6.1		gm

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

② See MIL-STD-750 Method 3471

③ Switching losses include the FRED and IGBT.

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

APT50GF60B2RD/LRD

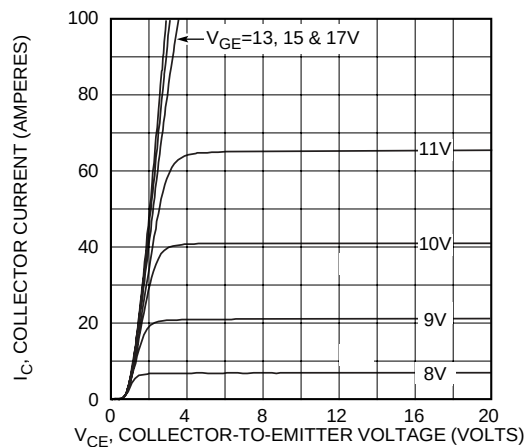


Figure 1, Typical Output Characteristics ($T_J = 25^\circ\text{C}$)

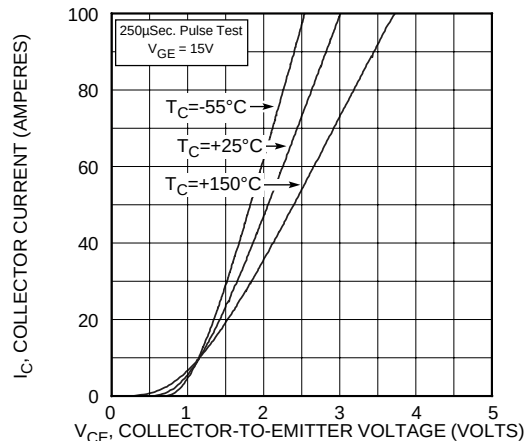


Figure 3, Typical Transfer Characteristics

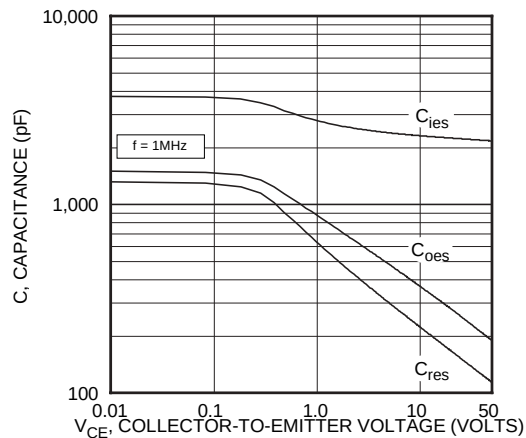


Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

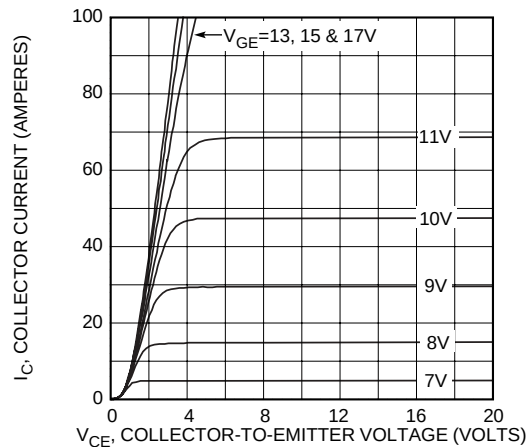


Figure 2, Typical Output Characteristics ($T_J = 150^\circ\text{C}$)

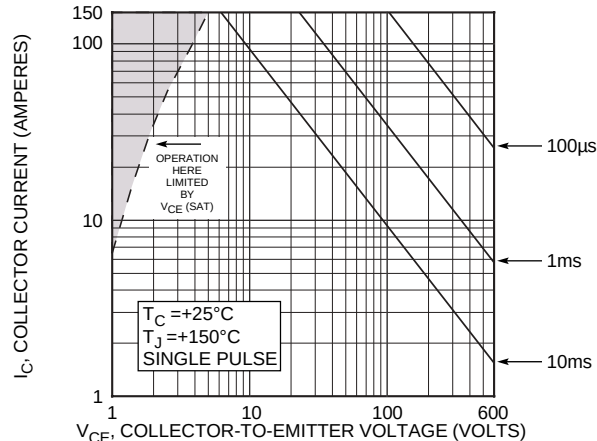


Figure 4, Maximum Safe Operating Area

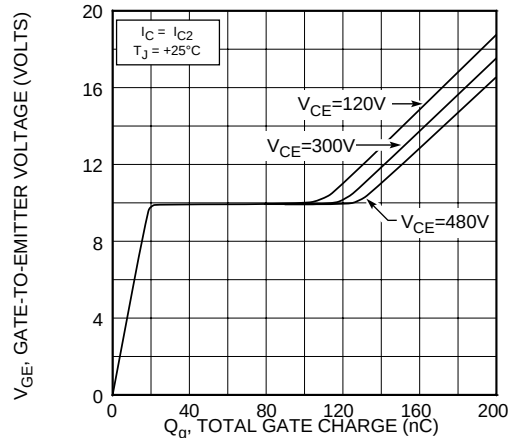


Figure 6, Gate Charges vs Gate-To-Emitter Voltage

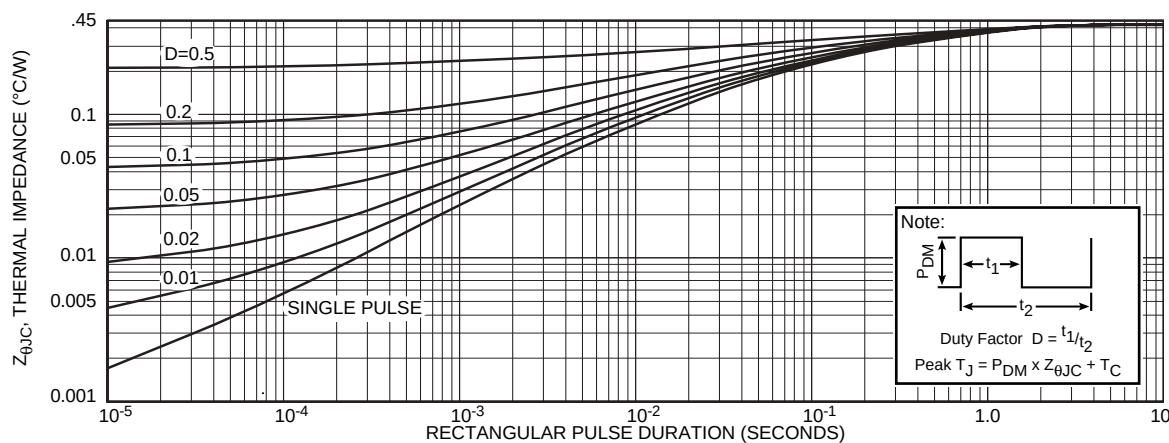


Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

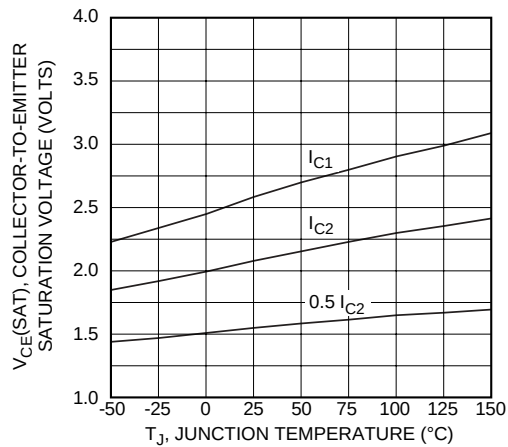


Figure 8, Typical $V_{CE(SAT)}$ Voltage vs Junction Temperature

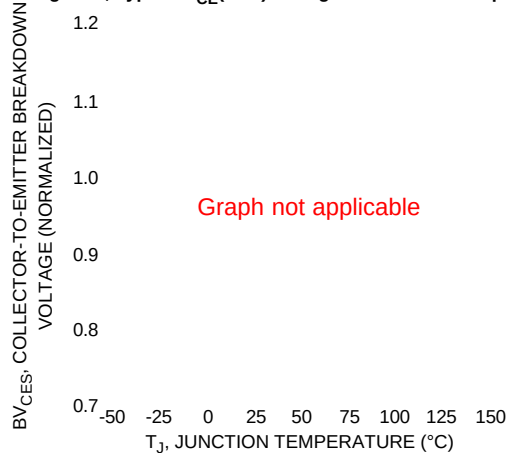


Figure 10, Breakdown Voltage vs Junction Temperature

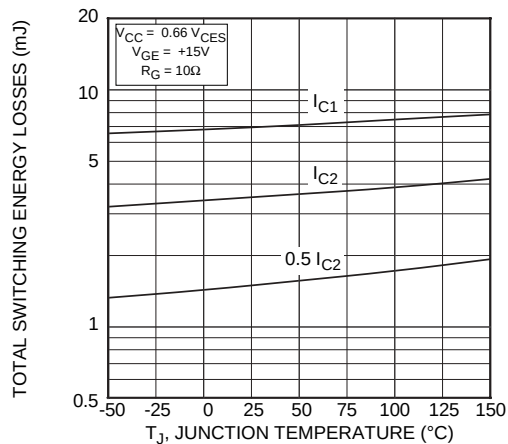


Figure 12, Typical Switching Energy Losses vs. Junction Temperature

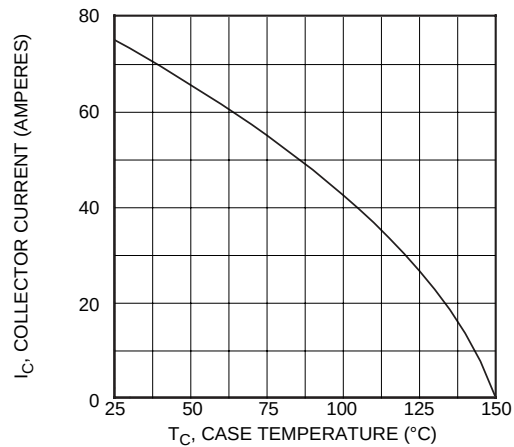


Figure 9, Maximum Collector Current vs Case Temperature

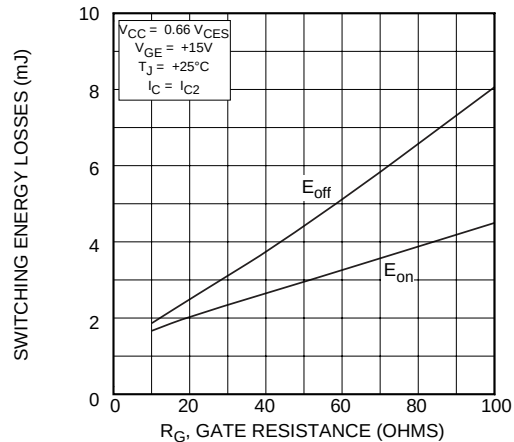


Figure 11, Typical Switching Energy Losses vs Gate Resistance

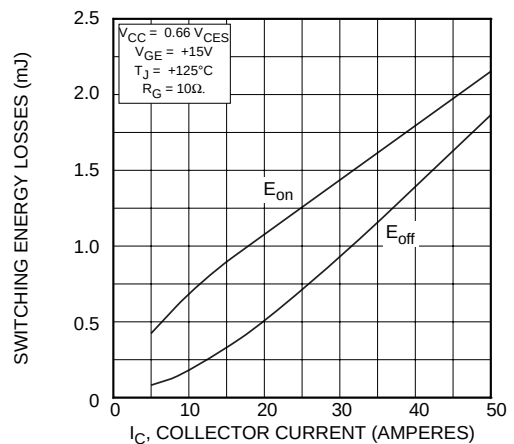


Figure 13, Typical Switching Energy Losses vs Collector Current

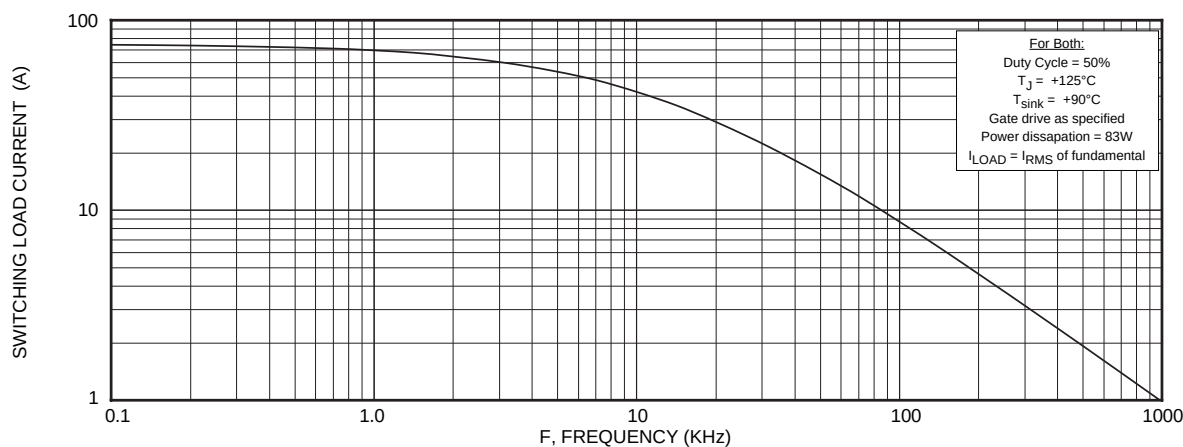


Figure 14, Typical Load Current vs Frequency

APT50GF60B2RD/LRD

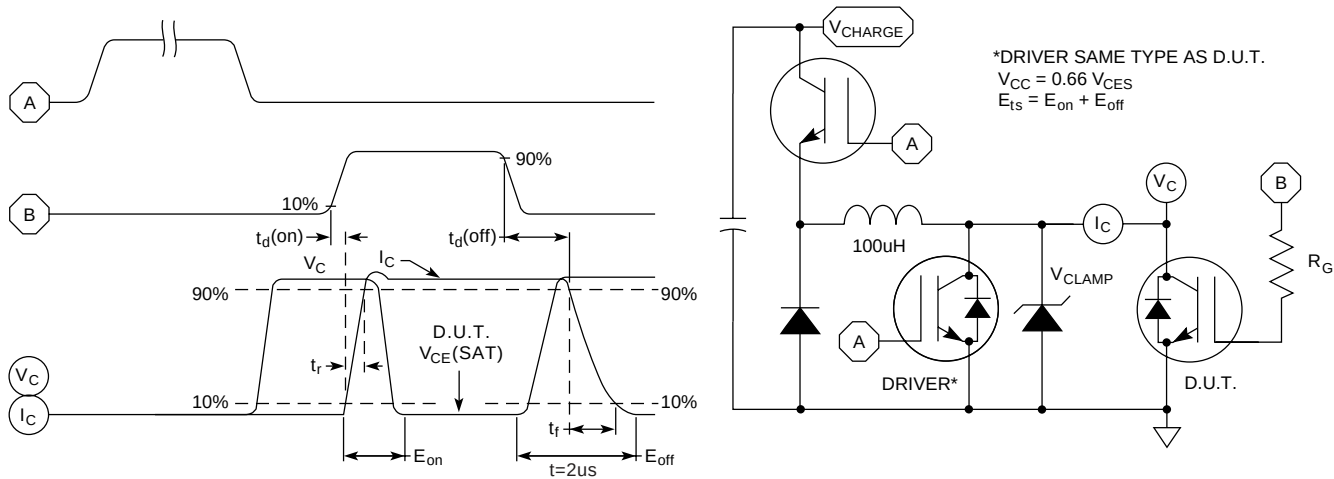


Figure 15, Switching Loss Test Circuit and Waveforms

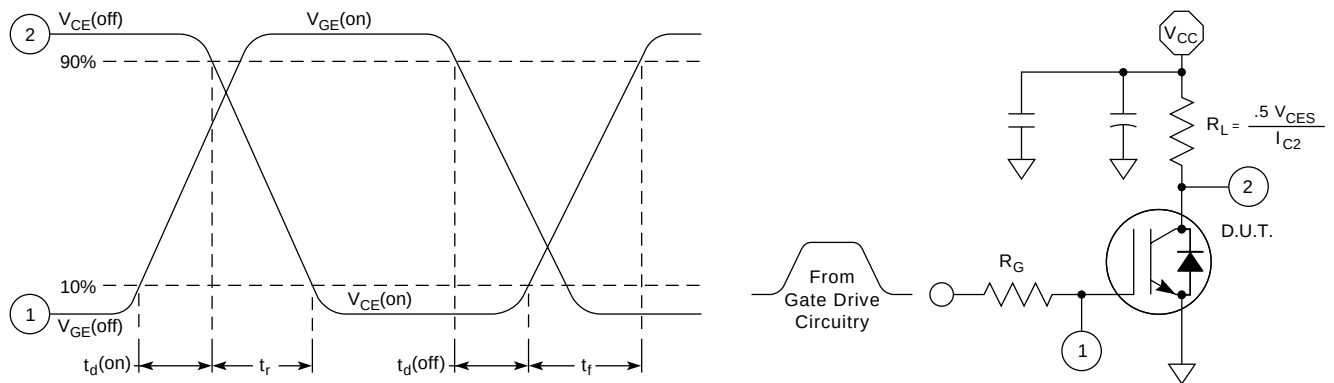


Figure 16, Resistive Switching Time Test Circuit and Waveforms

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

Symbol	Characteristic	50GF60B2RD/LRD	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	

STATIC ELECTRICAL CHARACTERISTICS (FRED)

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)

Symbol	Characteristic/ Test Conditions	MIN	TYP	MAX	UNIT
t_{rr1}	Reverse Recovery Time, $I_F = 1.0A$, $di_F/dt = -15A/\mu s$, $V_R = 30V$, $T_J = 25^\circ C$		55	70	ns
t_{rr2}	Reverse Recovery Time	$T_J = 25^\circ C$	70		
t_{rr3}	$I_F = 60A$, $di_F/dt = -480A/\mu s$, $V_R = 350V$	$T_J = 100^\circ C$	90		
t_{fr1}	Forward Recovery Time	$T_J = 25^\circ C$	160		
t_{fr2}	$I_F = 60A$, $di_F/dt = 480A/\mu s$, $V_R = 350V$	$T_J = 100^\circ C$	160		
I_{RRM1}	Reverse Recovery Current	$T_J = 25^\circ C$	10	17	Amps
I_{RRM2}	$I_F = 50A$, $di_F/dt = -480A/\mu s$, $V_R = 350V$	$T_J = 100^\circ C$	20	30	
Q_{rr1}	Recovery Charge	$T_J = 25^\circ C$	350		nC
Q_{rr2}	$I_F = 60A$, $di_F/dt = -480A/\mu s$, $V_R = 350V$	$T_J = 100^\circ C$	900		
V_{fr1}	Forward Recovery Voltage	$T_J = 25^\circ C$	6		Volts
V_{fr2}	$I_F = 60A$, $di_F/dt = 480A/\mu s$, $V_R = 350V$	$T_J = 100^\circ C$	6		
diM/dt	Rate of Fall of Recovery Current	$T_J = 25^\circ C$	800		A/ μs
	$I_F = 60A$, $di_F/dt = -480A/\mu s$, $V_R = 350V$ (See Figure 18)	$T_J = 100^\circ C$	500		

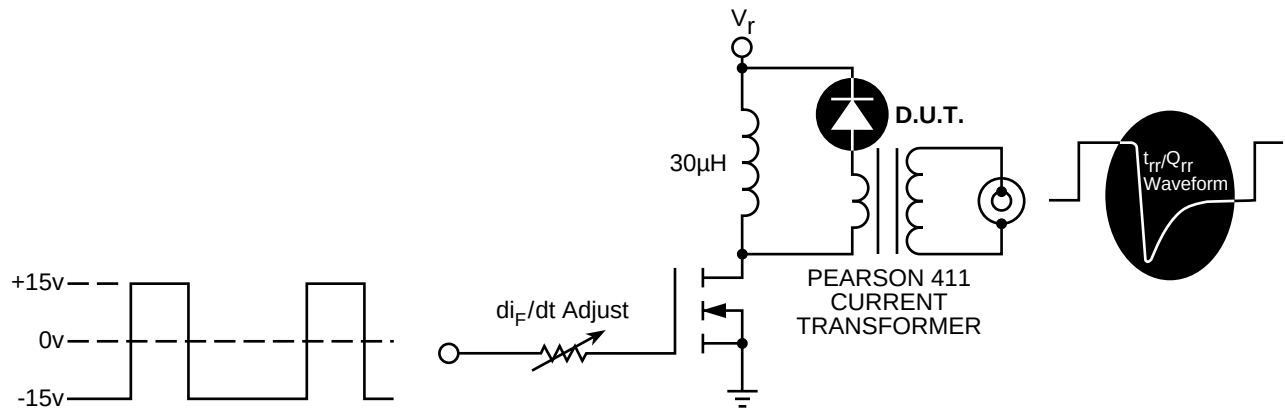


Figure 17, Diode Reverse Recovery Test Circuit and Waveforms

- 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} .

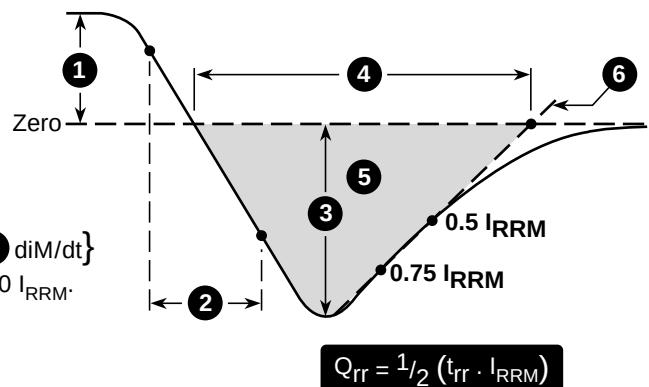


Figure 18, Diode Reverse Recovery Waveform and Definitions

APT50GF60B2RD/LRD

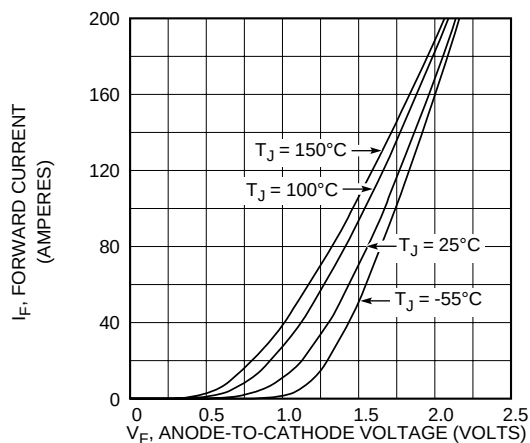


Figure 19, Forward Voltage Drop vs Forward Current

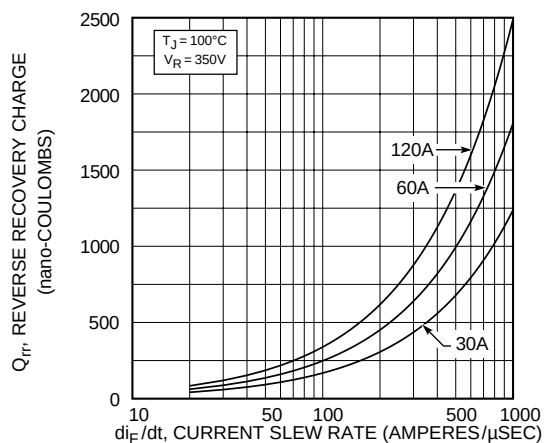


Figure 20, Reverse Recovery Charge vs Current Slew Rate

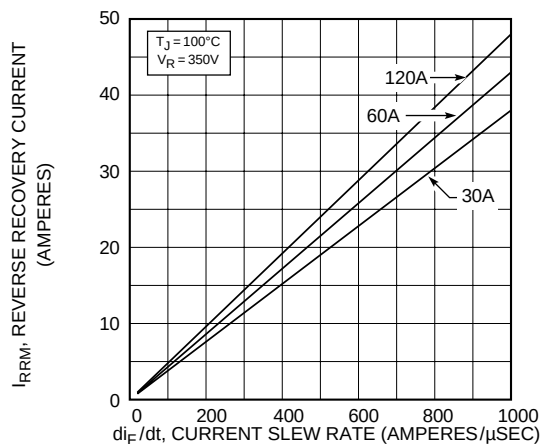


Figure 21, Reverse Recovery Current vs Current Slew Rate

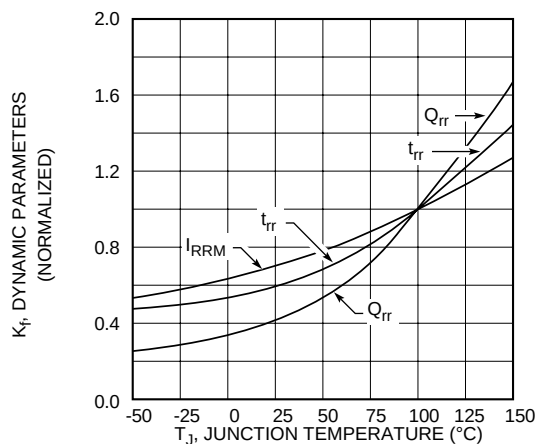


Figure 22, Dynamic Parameters vs Junction Temperature

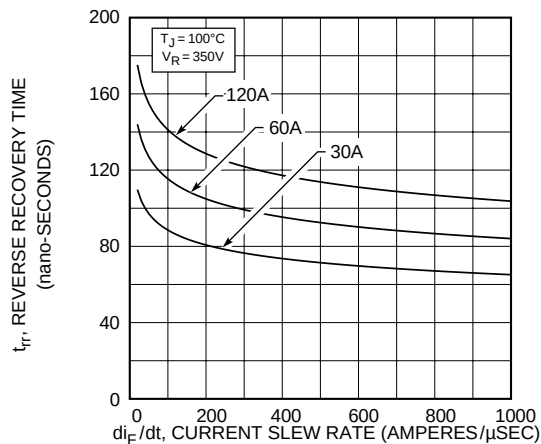


Figure 23, Reverse Recovery Time vs Current Slew Rate

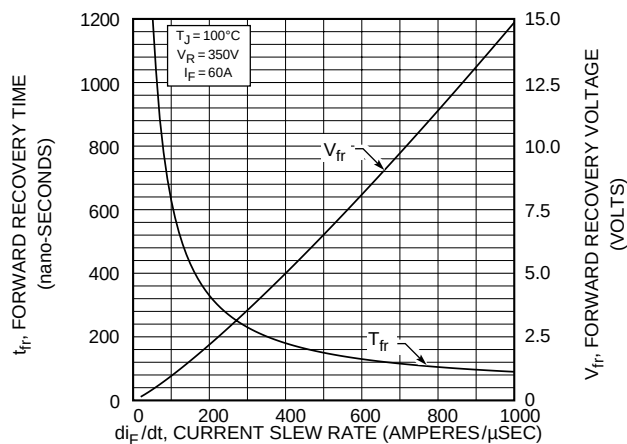


Figure 24, Forward Recovery Voltage/Time vs Current Slew Rate

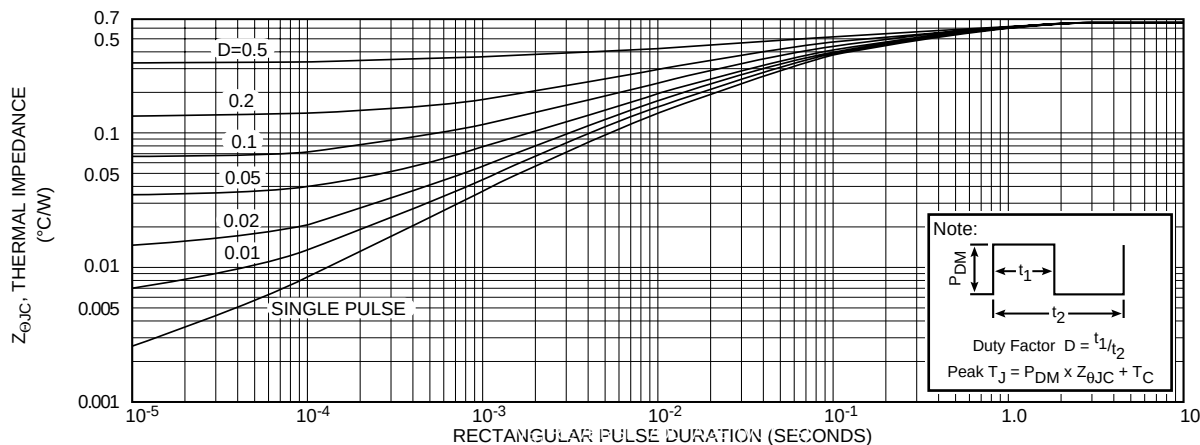
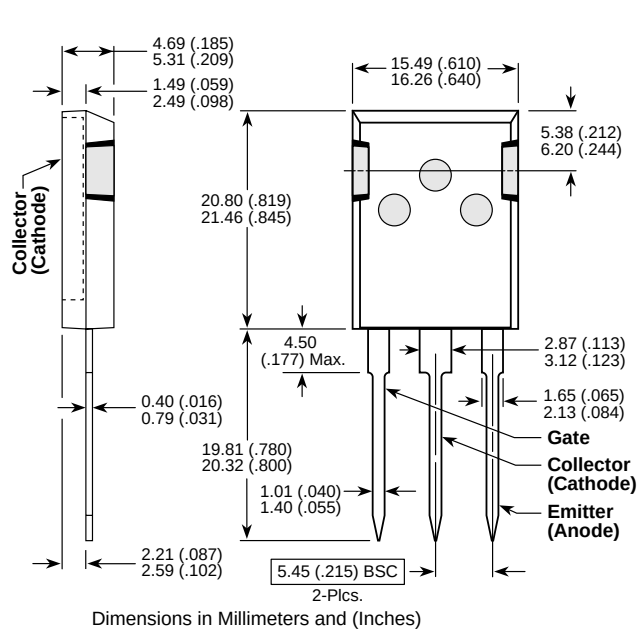


Figure 25, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

T-MAX™ (B2) Package Outline



TO-264 (L) Package Outline

