Microsemi
POWER PRODUCTS GROUP

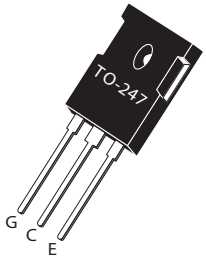
600V

APT50GT60BRDL(G)

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

Resonant Mode Combi IGBT®

The Thunderbolt IGBT® used in this Resonant Mode Combi is a new generation of high voltage power IGBTs. Using Non- Punch Through Technology, the Thunderblot IGBT® offers superior ruggedness and ultrafast switching speed.

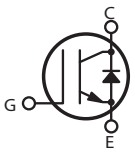


Features

- **Low Conduction Loss**
- **Low Gate Charge**
- **Ultrafast Tail Current shutoff**
- **Low forward Diode Voltage (V_F)**
- **Ultrasoft Recovery Diode**
- **SSOA Rated**
- **RoHS Compliant**

Typical Applications

- **Induction Heating**
- **Welding**
- **Medical**
- **High Power Telecom**
- **Resonant Mode Phase Shifted Bridge**



MAXIMUM RATINGS

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

Symbol	Parameter	APT50GT60BRDL(G)	UNIT
V_{CES}	Collector-Emitter Voltage	600	Volts
V_{GE}	Gate-Emitter Voltage	±30	
I_{C1}	Continuous Collector Current [7] @ T_C = 25°C	110	Amps
I_{C2}	Continuous Collector Current @ T_C = 110°C	52	
I_{CM}	Pulsed Collector Current [1] @ T_C = 150°C	150	
SSOA	Switching Safe Operating Area @ T_J = 150°C	150A @ 600V	
P_D	Total Power Dissipation	446	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 = 2mA)	600			Volts
$V_{GE(TH)}$	Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 1mA, T_j = 25°C)	3	4	5	
$V_{CE(ON)}$	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 50A, T_j = 25°C)	1.7	2.0	2.5	
	Collector-Emitter On Voltage (V_{GE} = 15V, I_C = 50A, T_j = 125°C)		2.2		
I_{CES}	Collector Cut-off Current (V_{CE} = 600V, V_{GE} = 0V, T_j = 25°C) [2]			50	µA
	Collector Cut-off Current (V_{CE} = 600V, V_{GE} = 0V, T_j = 125°C) [2]			1250	
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.

DYNAMIC CHARACTERISTICS

APT50GT60BRDL(G)

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
C_{ies}	Input Capacitance	Capacitance		2500		pF
C_{oes}	Output Capacitance	V_{GE} = 0V, V_{CE} = 25V		250		
C_{res}	Reverse Transfer Capacitance	f = 1 MHz		155		
V_{GEP}	Gate-to-Emitter Plateau Voltage	Gate Charge		7.5		V
Q_g	Total Gate Charge [3]	V_{GE} = 15V		240		nC
Q_{ge}	Gate-Emitter Charge	V_{CE} = 300V		20		
Q_{gc}	Gate-Collector ("Miller") Charge	I_C = 50A		110		
SSOA	Switching Safe Operating Area	T_J = 150°C, R_G = 5Ω, V_{GE} = 15V, L = 100µH, V_{CE} = 600V	150			A
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C)		14		ns
t_r	Current Rise Time	V_{CC} = 400V		32		
$t_{d(off)}$	Turn-off Delay Time	V_{GE} = 15V		240		
t_f	Current Fall Time	I_C = 50A		36		
E_{on1}	Turn-on Switching Energy [4]	R_G = 5Ω		995		µJ
E_{on2}	Turn-on Switching Energy (Diode) [5]	T_J = +25°C		1110		
E_{off}	Turn-off Switching Energy [6]			1070		
$t_{d(on)}$	Turn-on Delay Time	Inductive Switching (125°C)		14		ns
t_r	Current Rise Time	V_{CC} = 400V		32		
$t_{d(off)}$	Turn-off Delay Time	V_{GE} = 15V		270		
t_f	Current Fall Time	I_C = 50A		95		
E_{on1}	Turn-on Switching Energy [4]	R_G = 5Ω		1035		µJ
E_{on2}	Turn-on Switching Energy (Diode) [5]	T_J = +125°C		1655		
E_{off}	Turn-off Switching Energy [6]			1505		

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to Case (IGBT)			.28	°C/W
$R_{\theta JC}$	Junction to Case (DIODE)			.61	
W_T	Package Weight		5.9		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. Tested in inductive switching test circuit shown in figure 21, but with a Silicon Carbide diode.

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.)

⑦ Continuous current limited by package lead temperature.

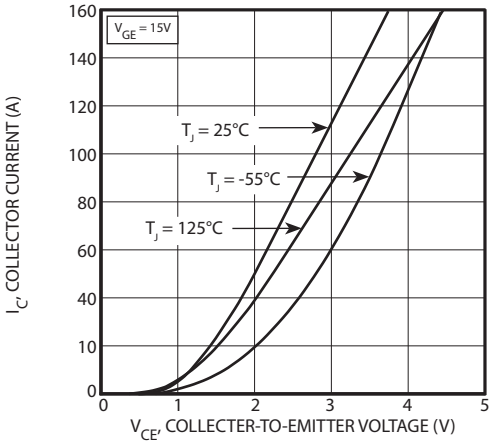


FIGURE 1, Output Characteristics(T_J = 25°C)

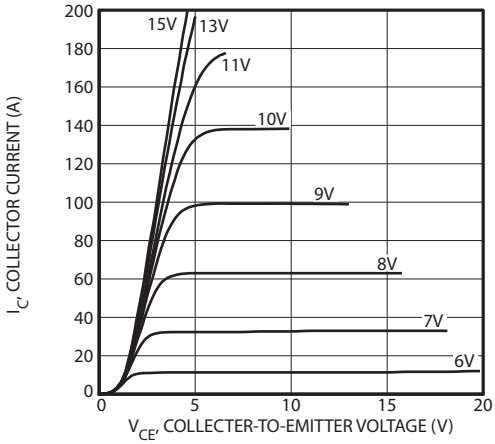


FIGURE 2, Output Characteristics (T_J = 125°C)

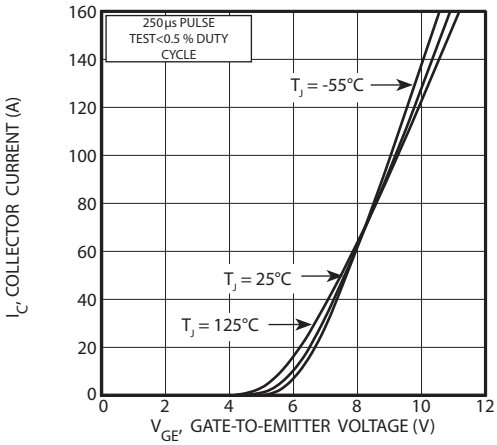


FIGURE 3, Transfer Characteristics

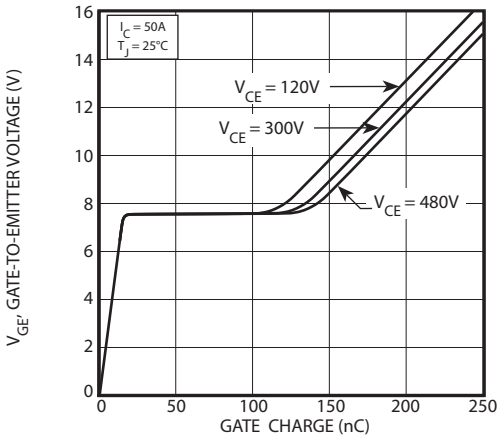


FIGURE 4, Gate Charge

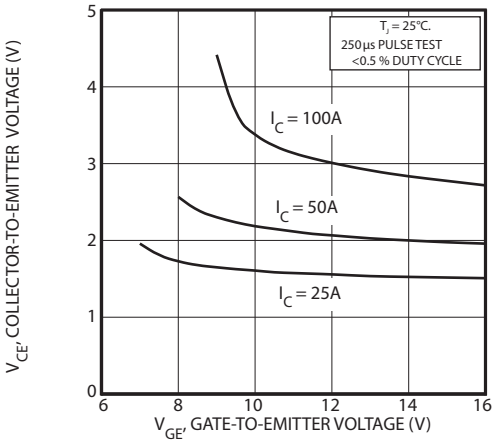


FIGURE 5, On State Voltage vs Gate-to- Emitter Voltage

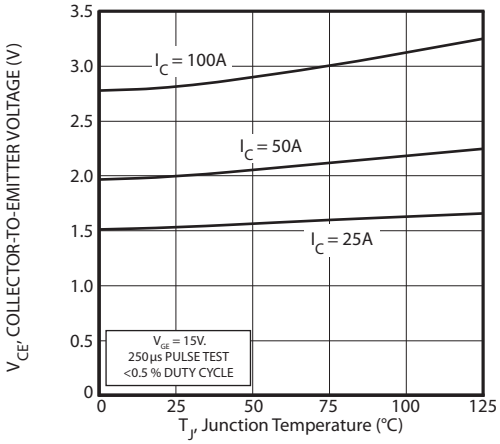


FIGURE 6, On State Voltage vs Junction Temperature

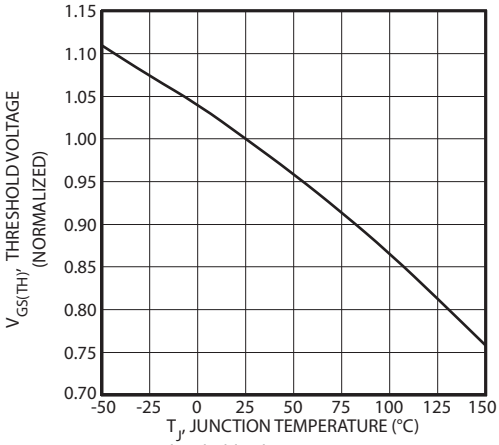


FIGURE 7, Threshold Voltage vs. Junction Temperature

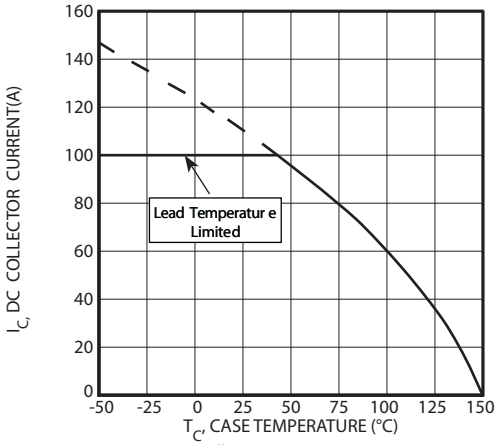


FIGURE 8, DC Collector Current vs Case Temperature

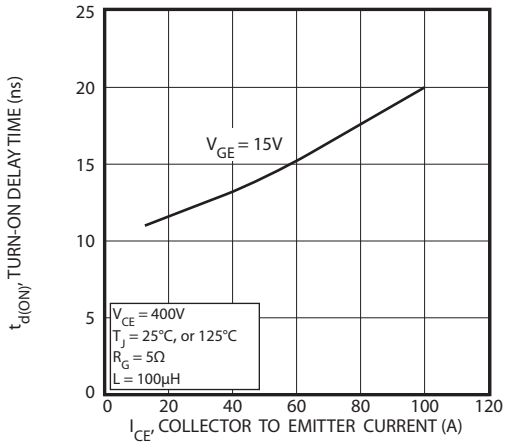


FIGURE 9, Turn-On Delay Time vs Collector Current

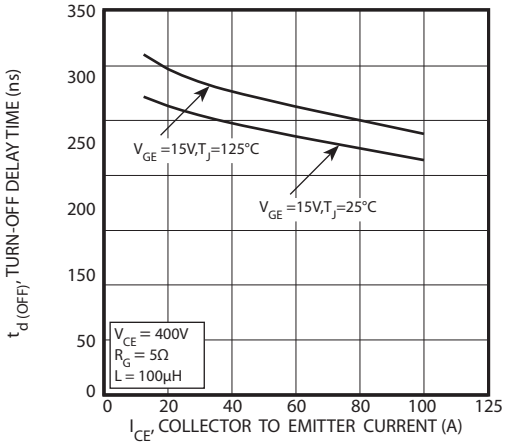


FIGURE 10, Turn-Off Delay Time vs Collector Current

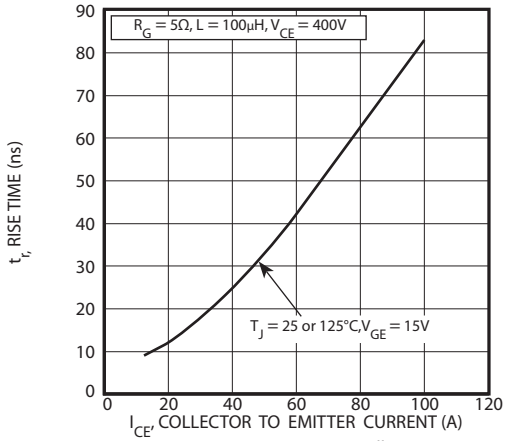


FIGURE 11, Current Rise Time vs Collector Current

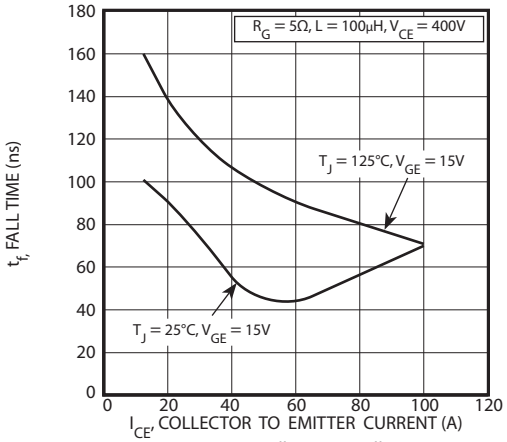


FIGURE 12, Current Fall Time vs Collector Current

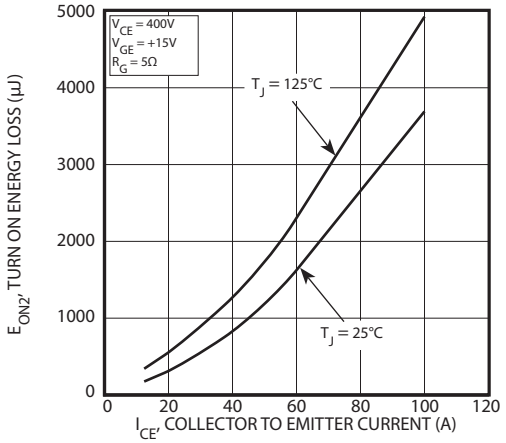


FIGURE 13, Turn-On Energy Loss vs Collector Current

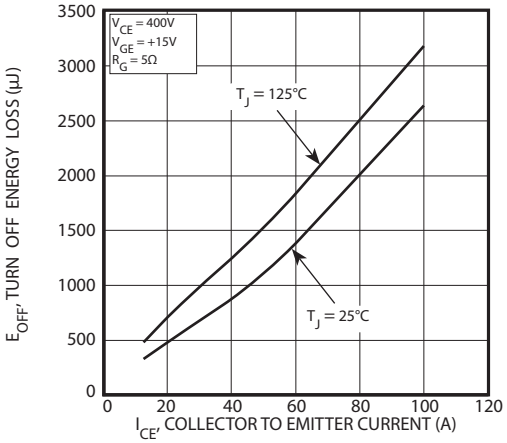


FIGURE 14, Turn Off Energy Loss vs Collector Current

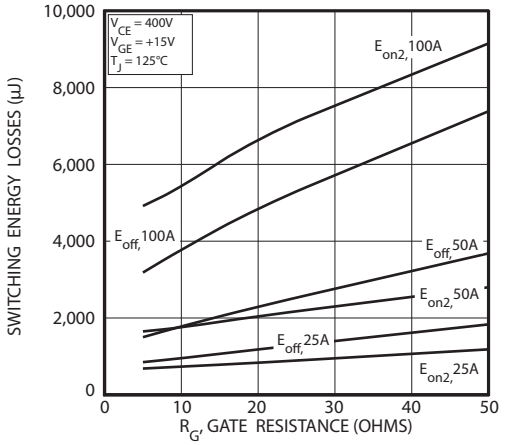


FIGURE 15, Switching Energy Losses vs. Gate Resistance

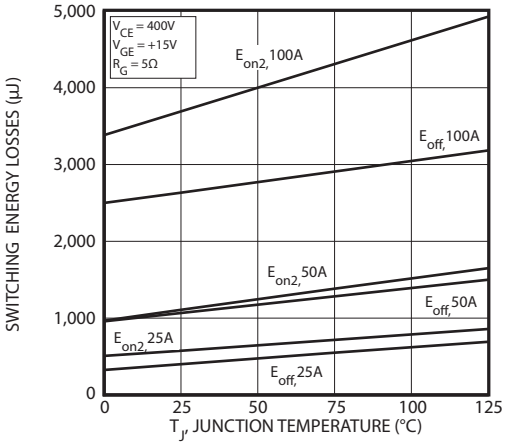


FIGURE 16, Switching Energy Losses vs Junction Temperature

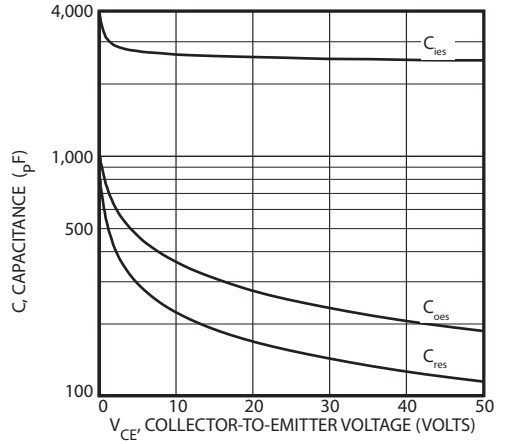


Figure 17, Capacitance vs Collector-To-Emitter Voltage

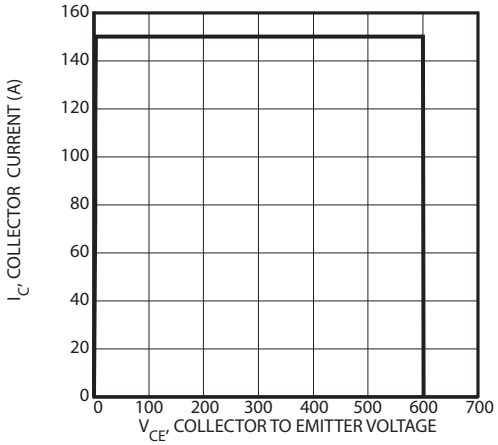


Figure 18,Minimim Switching Safe Operating Area

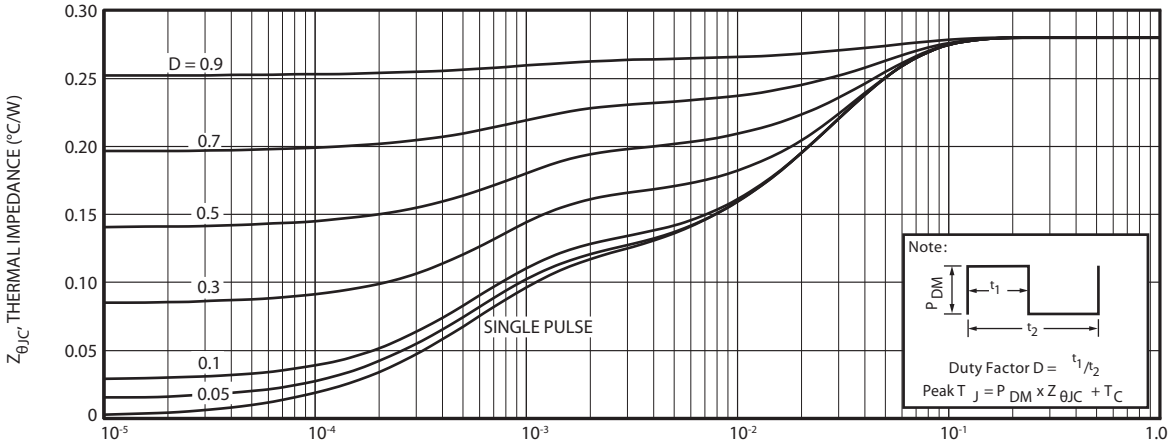


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

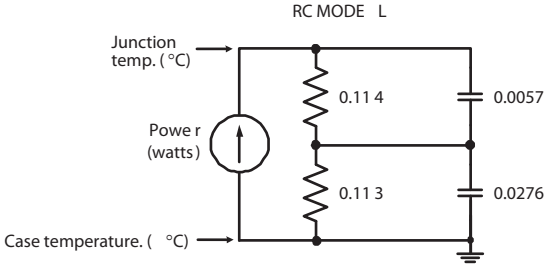


FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL

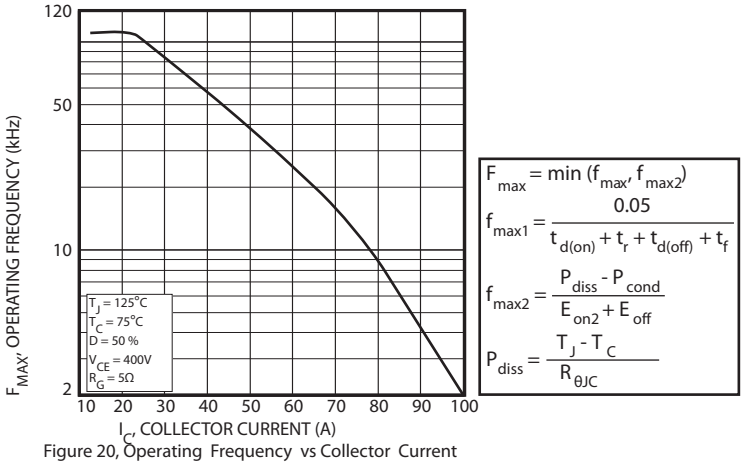


Figure 20, Operating Frequency vs Collector Current

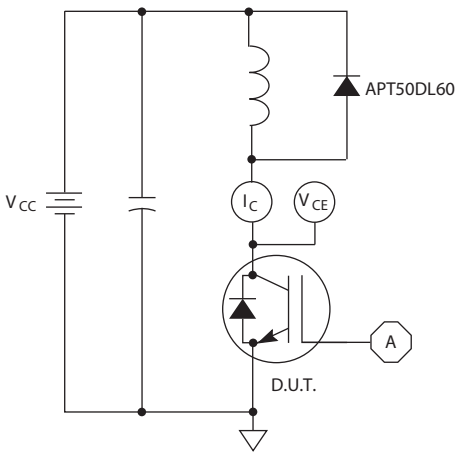


Figure 21, Inductive Switching Test Circui t

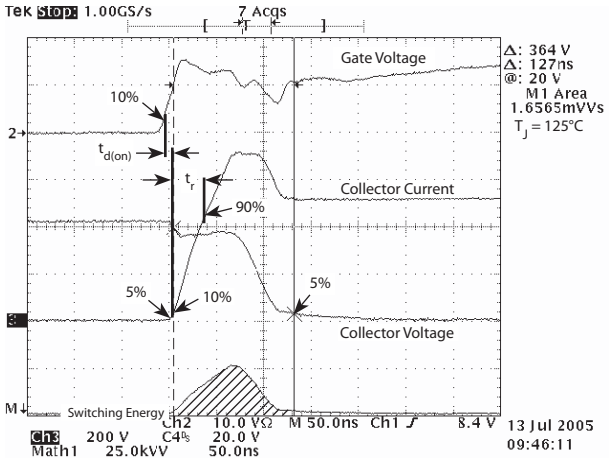


Figure 22, Turn-on Switching Waveforms and Definitions

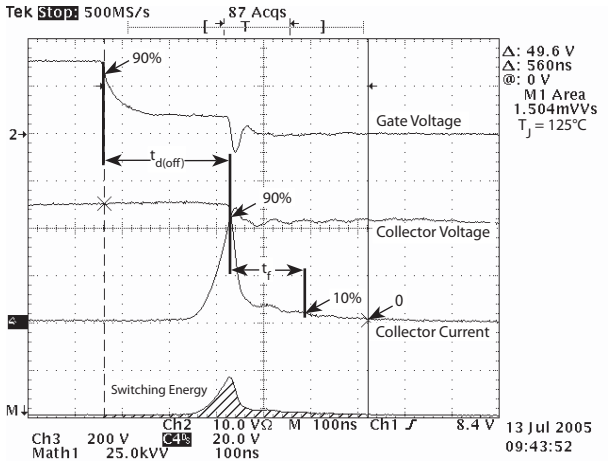


Figure 23, Turn-off Switching Waveforms and Definitions

ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

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

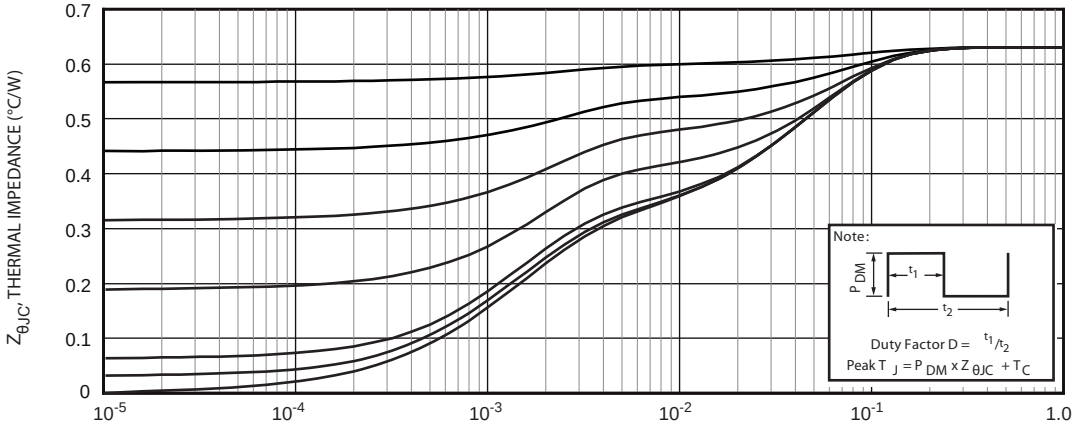
Symbol	Characteristic / Test Conditions	APT50GT60BRDL(G)			UNIT
$I_{F(AV)}$	Maximum Average Forward Current (T_C = 100°C, Duty Cycle = 0.5)		50		Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)		150		
I_{FSM}	Non-Repetitive Forward Surge Current (T_J = 45°C, 8.3ms)		320		

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Forward Voltage	I_F = 50A		1.25	1.6	Volts
		I_F = 100A		2.0		
		I_F = 50A, T_J = 125°C		1.25		

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	-	52		ns
t_{rr}	Reverse Recovery Time	I_F = 50A, di_F/dt = -200A/µs, V_R = 400V, T_C = 25°C	-	399		ns
Q_{rr}	Reverse Recovery Charge		-	1498		nC
I_{RRM}	Maximum Reverse Recovery Current		-	9	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 50A, di_F/dt = -200A/µs, V_R = 400V, T_C = 125°C	-	649		ns
Q_{rr}	Reverse Recovery Charge		-	3734		nC
I_{RRM}	Maximum Reverse Recovery Current		-	13	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 50A, di_F/dt = -1000A/µs, V_R = 400V, T_C = 125°C	-	284		ns
Q_{rr}	Reverse Recovery Charge		-	5134		nC
I_{RRM}	Maximum Reverse Recovery Current		-	34		Amps



RECTANGULAR PULSE DURATION (seconds)

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

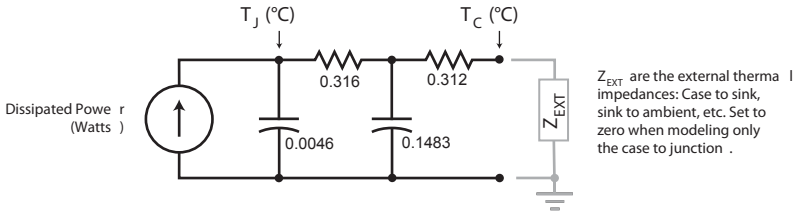


FIGURE 1b, TRANSIENT THERMAL IMPEDANCE MODEL

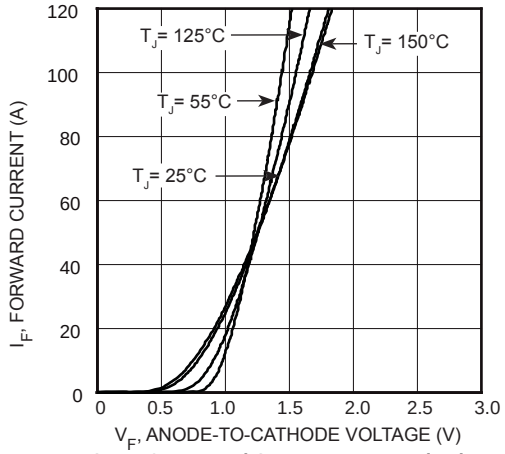


FIGURE 2, Forward Current vs. Forward Voltage

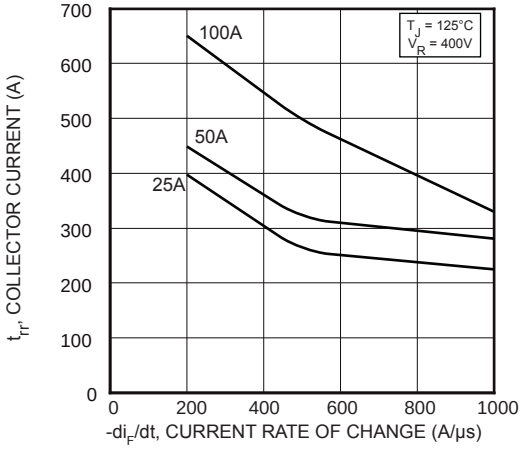


FIGURE 3, Reverse Recovery Time vs. Current Rate of Change

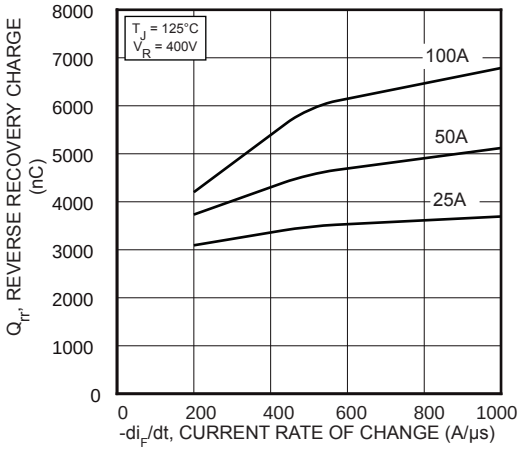


FIGURE 4, Reverse Recovery Charge vs. Current Rate of Change

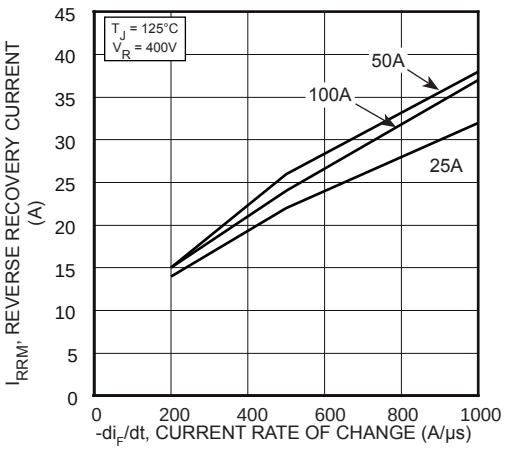


FIGURE 5, Reverse Recovery Current vs. Current Rate of Change

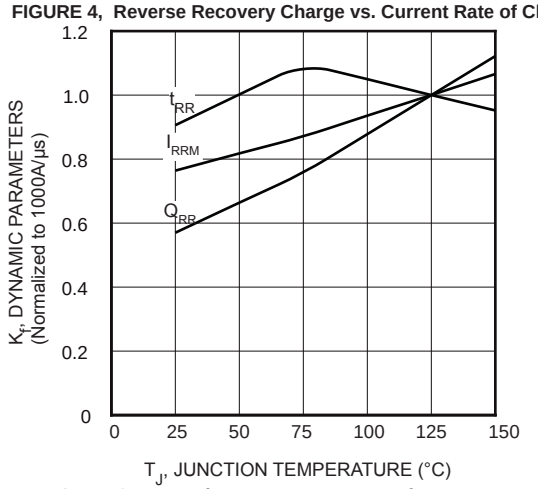


FIGURE 6, Dynamic Parameters vs Junction Temperature

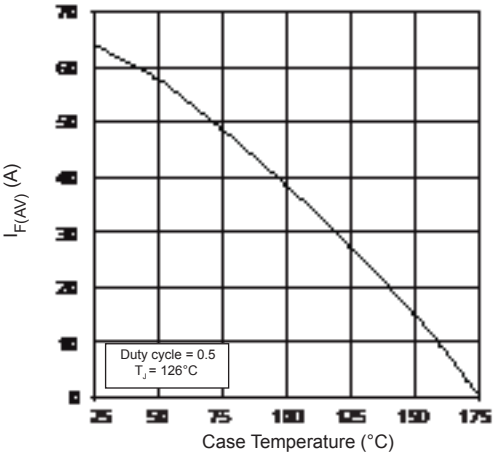


FIGURE 7, Maximum Average Forward Current vs. Case Temperature

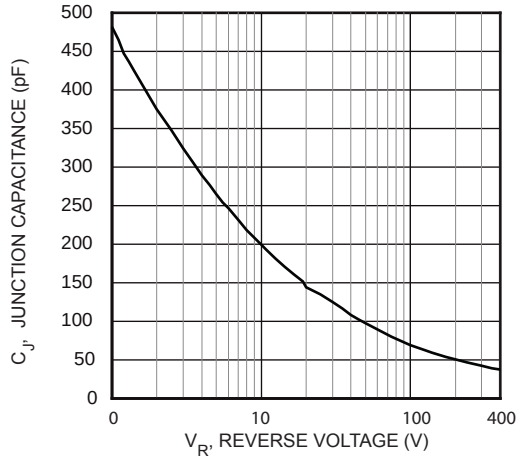


FIGURE 8, Junction Capacitance vs. Reverse Voltage

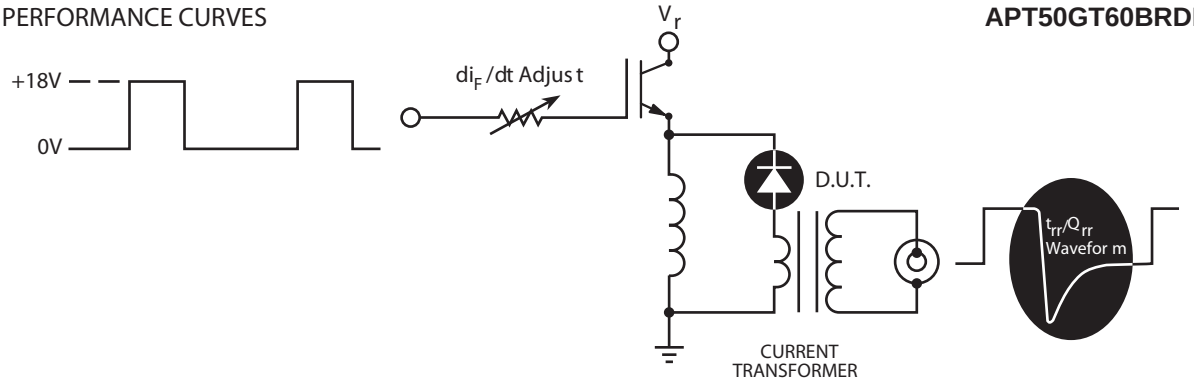
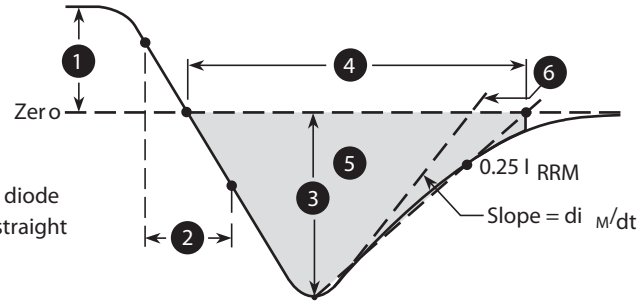


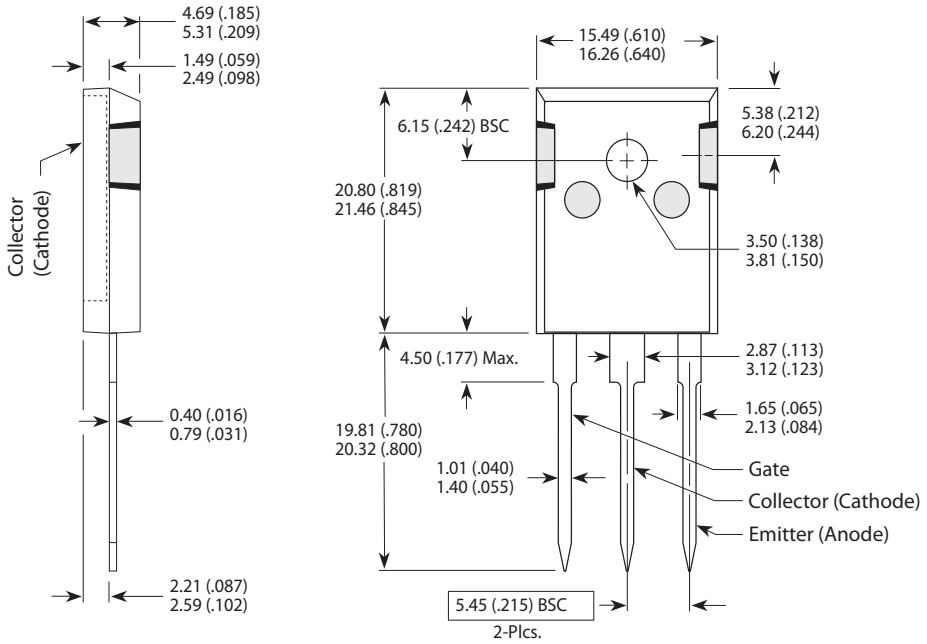
Figure 9. Diode Test Circuit



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 the diode current goes from positive to negative, to the point at which the straight line through I_{RRM} and 0.25 I_{RRM} passes through zero.
5. Q_{rr} - Area Under the Curve Defined by I_{RRM} and t_{rr}.
6. di_M/dt - Maximum Rate of Current Increase During the Trailing Portion of t_{rr}.

Figure 10, Diode Reverse Recovery Waveform and Definitions

TO-247 (B) Package Outline



Dimensions in Millimeters and (Inches)