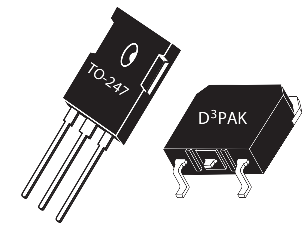
APT30GS60BRDQ2(G)
APT30GS60SRDQ2(G)

600V, 30A, $V_{CE(ON)}$ = 2.8V Typical

Thunderbolt® High Speed NPT IGBT with Anti-Parallel 'DQ' Diode

The Thunderbolt HS™ series is based on thin wafer non-punch through (NPT) technology similar to the Thunderbolt® series, but trades higher $V_{CE(ON)}$ for significantly lower turn-on energy E_{off}. The low switching losses enable operation at switching frequencies over 100kHz, approaching power MOSFET performance but lower cost.

An extremely tight parameter distribution combined with a positive $V_{CE(ON)}$ temperature coefficient make it easy to parallel Thunderbolts HS™ IGBT's. Controlled slew rates result in very good noise and oscillation immunity and low EMI. The short circuit duration rating of 10μs make these IGBT's suitable for motor drive and inverter applications. Reliability is further enhanced by avalanche energy ruggedness. Combi versions are packaged with a high speed, soft recovery DQ series diode.



APT30GS60BRDQ2(G) APT30GS60SRDQ2(G)

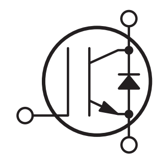
Features

- **Fast Switching with low EMI**
- **Very Low E_{OFF} for Maximum Efficiency**
- **Short circuit rated**
- **Low Gate Charge**
- **Tight parameter distribution**
- **Easy paralleling**
- **RoHS Compliant**

Typical Applications

- **ZVS Phase Shifted and other Full Bridge**
- **Half Bridge**
- **High Power PFC Boost**
- **Welding**
- **Induction heating**
- **High Frequency SMPS**

Single die IGBT with separate DQ diode die



Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
I_{C1}	Continuous Collector Current T_C = @ 25°C		54	A
I_{C2}	Continuous Collector Current T_C = @ 100°C		30	
I_{CM}	Pulsed Collector Current ①		113	
V_{GE}	Gate-Emitter Voltage		±30V	V
SSOA	Switching Safe Operating Area		113	
E_{AS}	Single Pulse Avalanche Energy ②		20	mJ
t_{SC}	Short Circut Withstand Time ②		10	μs
I_F	Diode Continuous Forward Current	T_C = 25°C	90	A
		T_C = 100°C	55	
I_{FRM}	Diode Max. Repetitive Forward Current		113	

Thermal and Mechanical Characteristics

Symbol	Parameter		Min	Typ	Max	Unit
P_D	Total Power Dissipation T_C = @ 25°C				250	W
$R_{\theta JC}$	Junction to Case Thermal Resistance	IGBT			0.50	°C/W
		Diode			0.67	
$R_{\theta CS}$	Case to Sink Thermal Resistance, Flat Greased Surface			0.11		
T_J, T_{STG}	Operating and Storage Junction Temperature Range		-55		150	°C
T_L	Soldering Temperature for 10 Seconds (1.6mm from case)				300	
W_T	Package Weight			0.22		oz
				5.9		g
Torque	Mounting Torque (TO-247), 6-32 M3 Screw				10	in·lbf
					1.1	N·m

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

Static Characteristics — T_J = 25°C unless otherwise specified

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(CES)}$	Collector-Emitter Breakdown Voltage	V_{GE} = 0V, I_C = 250μA		600			V
$\Delta V_{BR(CES)}/\Delta T_J$	Breakdown Voltage Temperature Coeff	Reference to 25°C, I_C = 250μA			0.60		V/°C
$V_{CE(ON)}$	Collector-Emitter On Voltage (3)	V_{GE} = 15V, I_C = 30A	T_J = 25°C		2.8	3.15	V
			T_J = 125°C		3.25		
V_{EC}	Diode Forward Voltage (3)	I_C = 30A	T_J = 25°C		1.85		
			T_J = 125°C		1.5		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{GE} = V_{CE}, I_C = 1mA		3	4	5	
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage Temp Coeff				6.7		mV/°C
I_{CES}	Zero Gate Voltage Collector Current	V_{CE} = 600V, V_{GE} = 0V	T_J = 25°C			50	μA
			T_J = 125°C			1000	
I_{GES}	Gate-Emitter Leakage Current	V_{GE} = ±20V				±100	nA

Dynamic Characteristics — T_J = 25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
g_{fs}	Forward Transconductance	V_{CE} = 50V, I_C = 30A		18		S
C_{ies}	Input Capacitance	V_{GE} = 0V, V_{CE} = 25V, f = 1MHz		1600		pF
C_{oes}	Output Capacitance			140		
C_{res}	Reverse Transfer Capacitance			90		
$C_{o(cr)}$	Reverse Transfer Capacitance Charge Related (4)	V_{GE} = 0V, V_{CE} = 0 to 400V		130		
$C_{o(er)}$	Reverse Transfer Capacitance Current Related (5)			95		
Q_g	Total Gate Charge	V_{GE} = 0 to 15V, I_C = 30A, V_{CE} = 300V		145		nC
Q_{ge}	Gate-Emitter Charge			12		
G_{gc}	Gate-Collector Charge			65		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching IGBT and Diode: T_J = 25°C, V_{CC} = 400V, I_C = 30A, R_G = 9.1Ω (6), V_{GG} = 15V		16		ns
t_r	Rise Time			29		
$t_{d(off)}$	Turn-Off Delay Time			360		
t_f	Fall Time			27		
E_{on1}	Turn-On Switching Energy (7)			TBD		μJ
E_{on2}	Turn-On Switching Energy (8)			800		
E_{off}	Turn-Off Switching Energy (9)			570		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching IGBT and Diode: T_J = 125°C, V_{CC} = 400V, I_C = 30A, R_G = 9.1Ω (6), V_{GG} = 15V		16		ns
t_r	Rise Time			29		
$t_{d(off)}$	Turn-Off Delay Time			390		
t_f	Fall Time			22		
E_{on1}	Turn-On Switching Energy (7)			TBD		μJ
E_{on2}	Turn-On Switching Energy (8)			1185		
E_{off}	Turn-Off Switching Energy (9)			695		
t_{rr}	Diode Reverse Recovery Time	I_F = 40A, V_R = 400V, di_F/dt = 200A/μs		25		ns
Q_{rr}	Diode Reverse Recovery Charge			35		nC
I_{rrm}	Peak Reverse Recovery Current			3		A

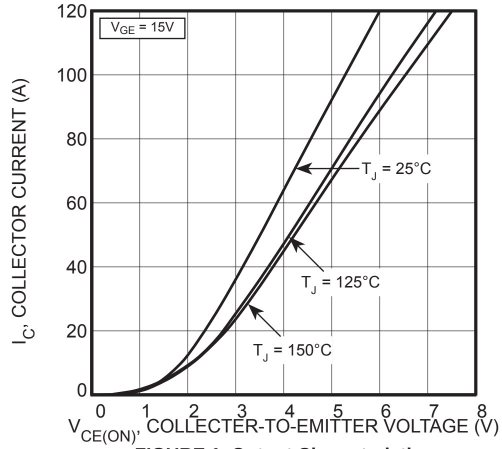


FIGURE 1, Output Characteristics

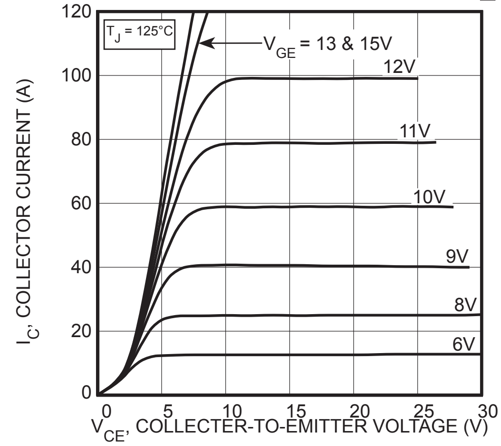


FIGURE 2, Output Characteristics

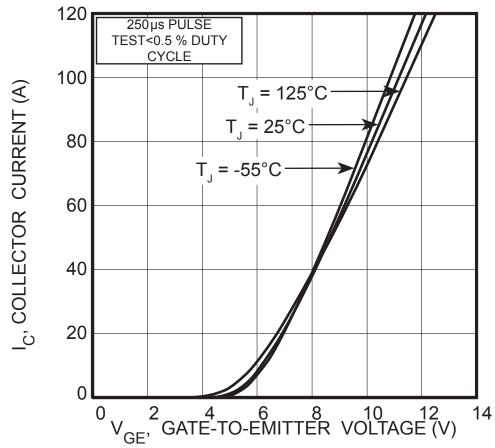


FIGURE 3, Transfer Characteristics

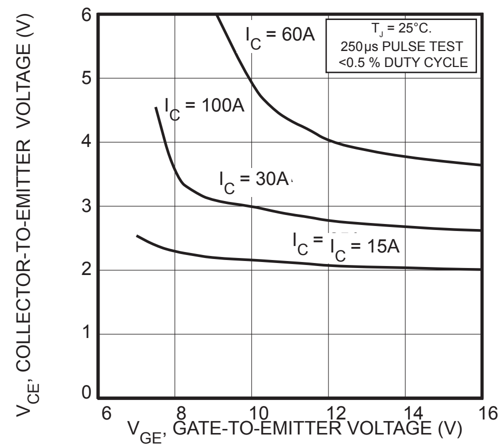


FIGURE 4, On State Voltage vs Gate-to- Emitter Voltage

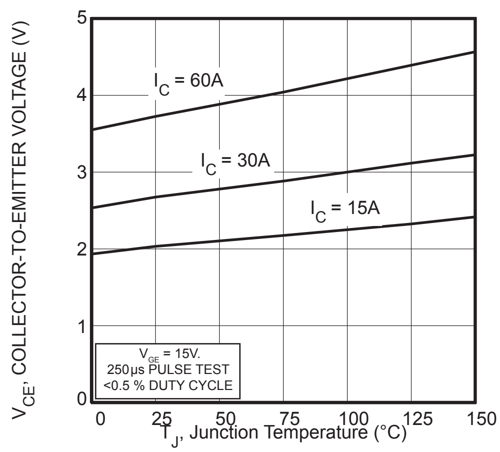


FIGURE 5, On State Voltage vs Junction Temperature

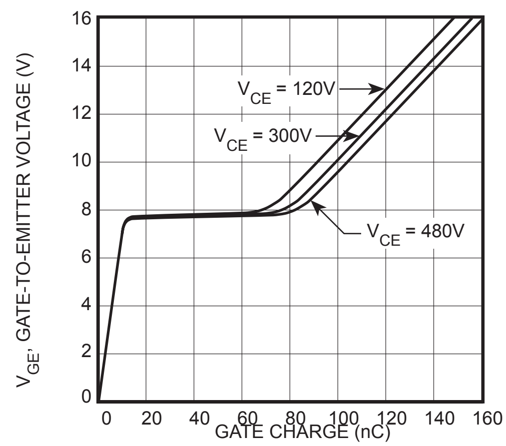


FIGURE 6, Gate Charge

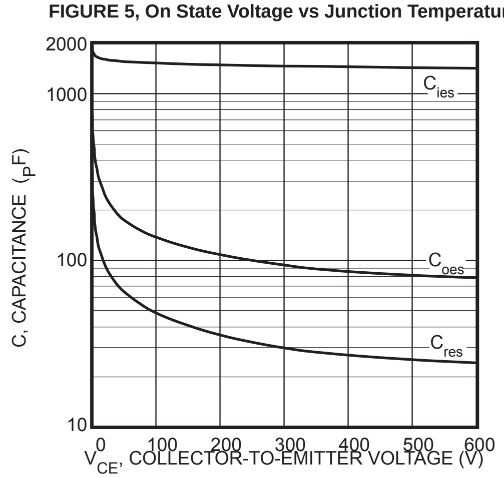


FIGURE 7, Capacitance vs Collector-To-Emitter Voltage

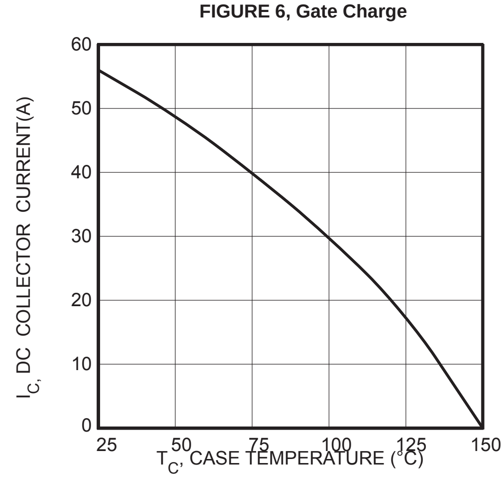


FIGURE 8, DC Collector Current vs Case Temperature

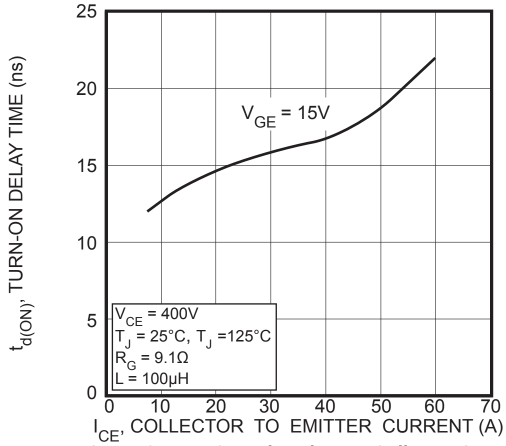


FIGURE 9, Turn-On Delay Time vs Collector Current

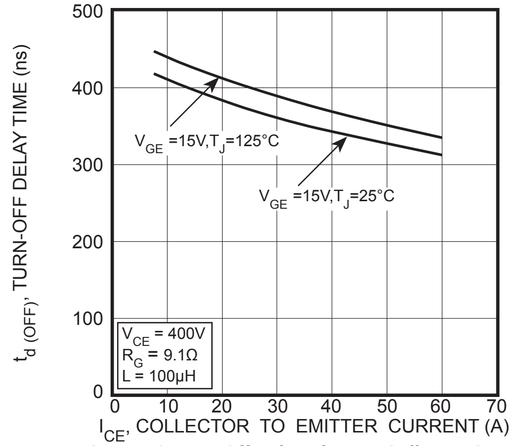


FIGURE 10, Turn-Off Delay Time vs Collector Current

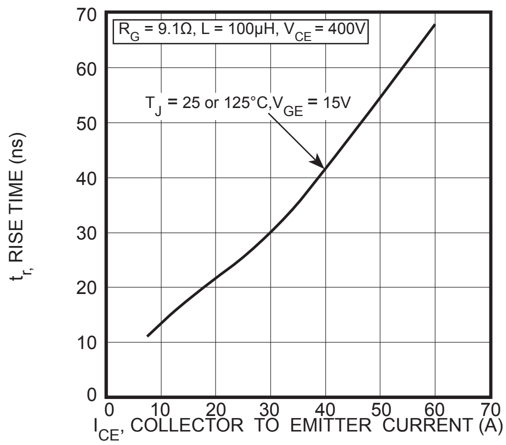


FIGURE 11, Current Rise Time vs Collector Current

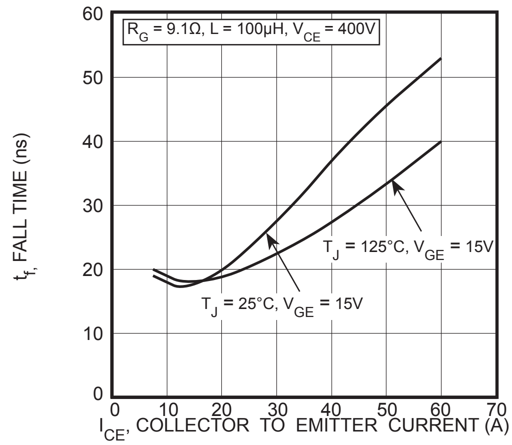


FIGURE 12, Current Fall Time vs Collector Current

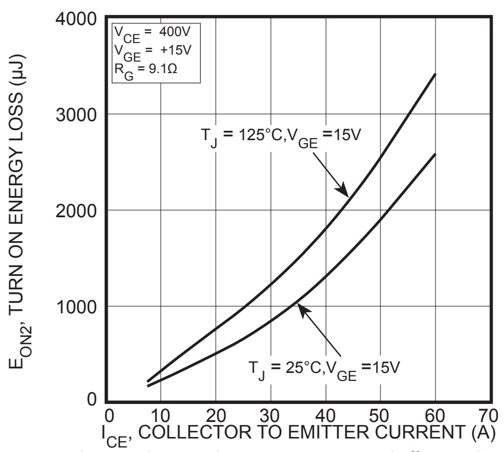


FIGURE 13, Turn-On Energy Loss vs Collector Current

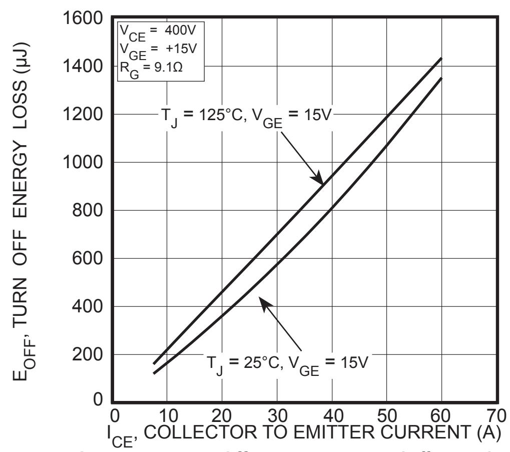


FIGURE 14, Turn Off Energy Loss vs Collector Current

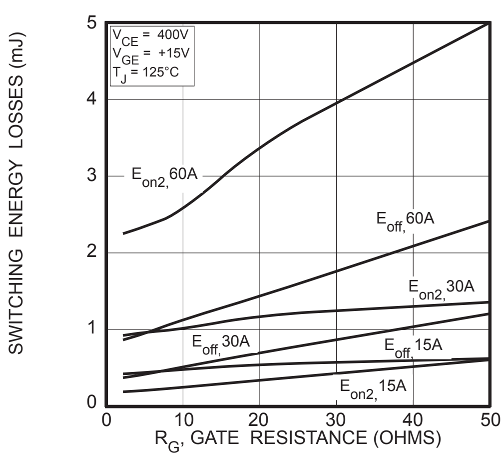


FIGURE 15, Switching Energy Losses vs. Gate Resistance

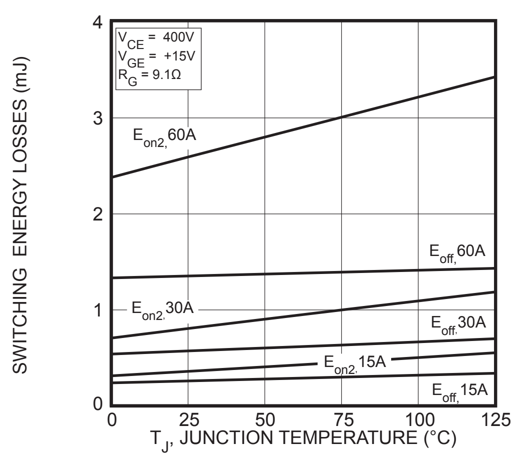


FIGURE 16, Switching Energy Losses vs Junction Temperature

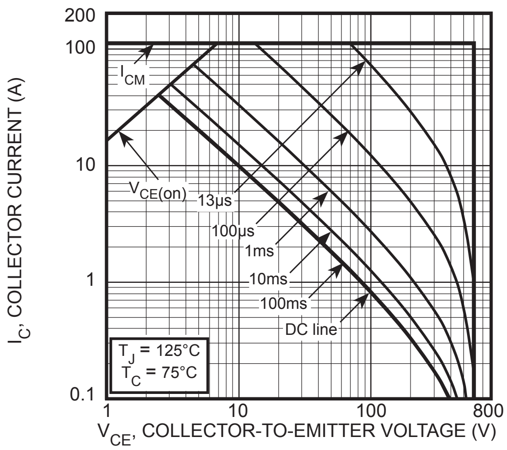


Figure 17, Forward Safe Operating Area

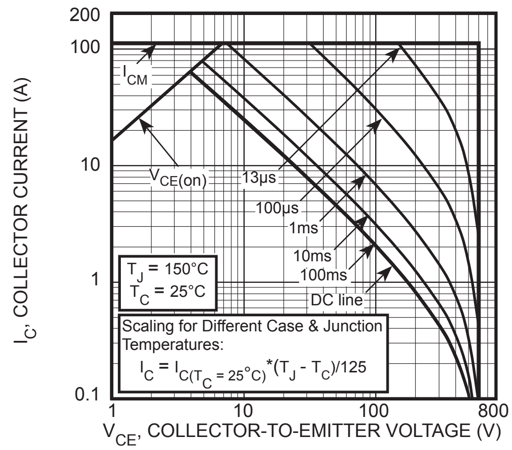


Figure 18, Maximum Forward Safe Operating Area

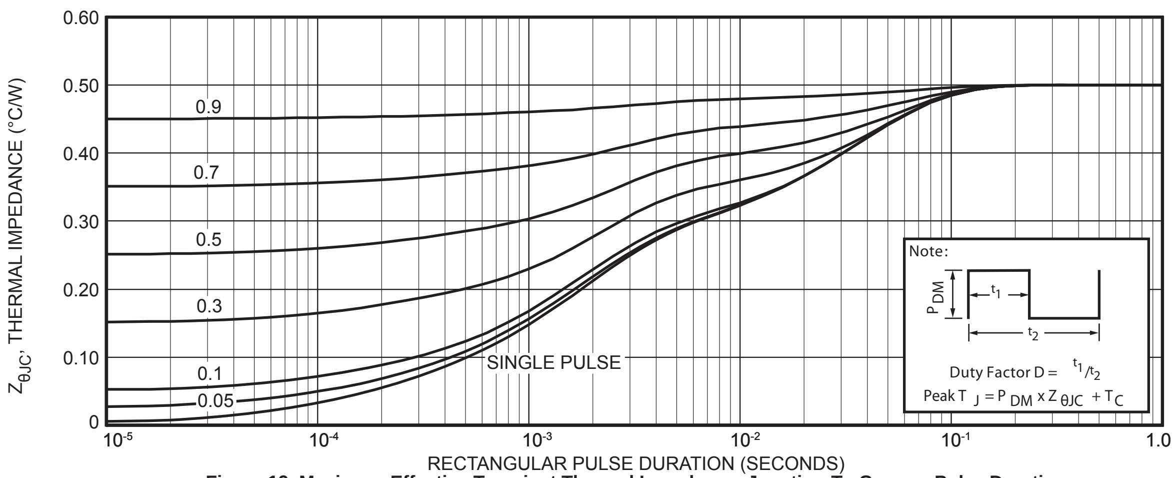
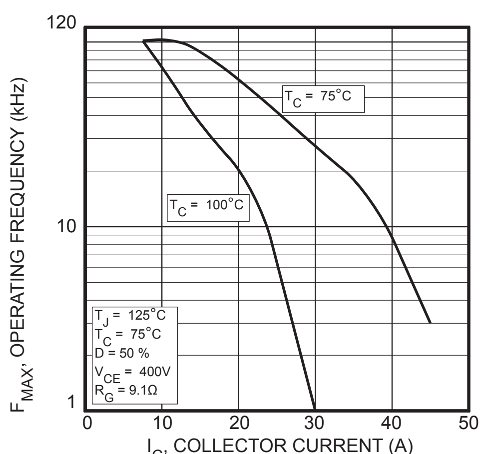


Figure 19, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration



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

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

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

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

Figure 20, Operating Frequency vs Collector Current

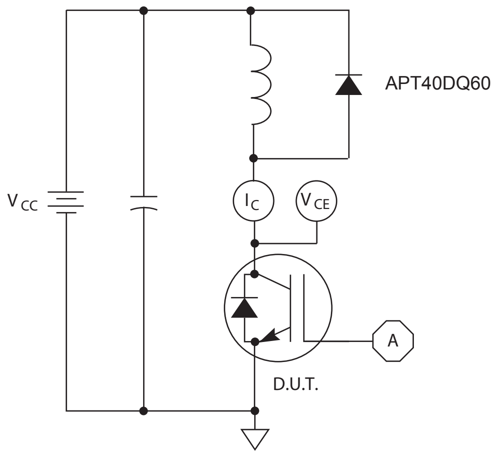


Figure 21, Inductive Switching Test Circuit

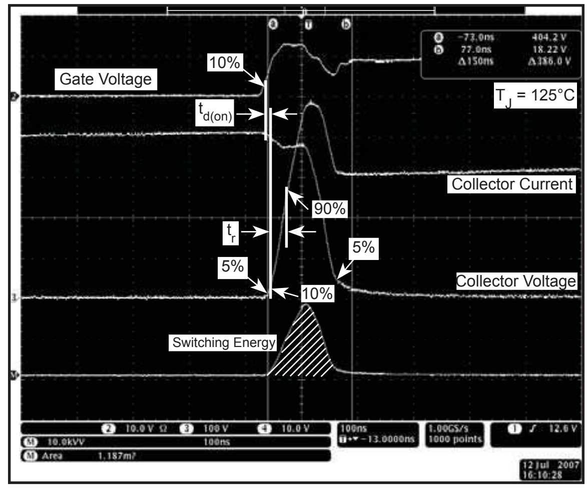


Figure 22, Turn-on Switching Waveforms and Definitions

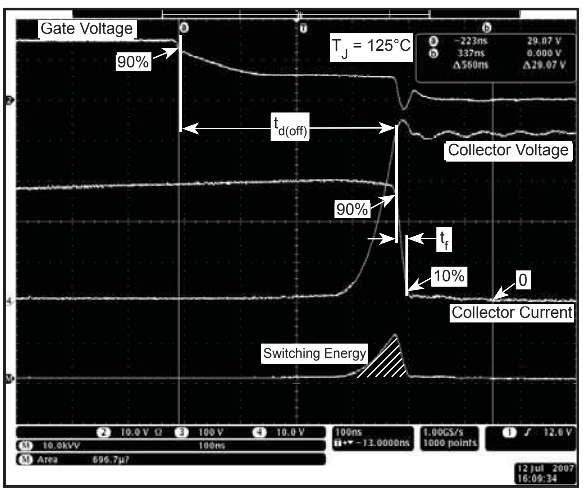


Figure 23, Turn-off Switching Waveforms and Definitions

FOOT NOTE:

① Repetitive Rating: Pulse width and case temperature limited by maximum junction temperature.
② Starting at T_J = 25°C, L = 224µH, R_G = 25Ω, I_C = 30A
③ Short circuit time: V_{GE} = 15V, V_{CC} ≤ 600V, T_J ≤ 150°C
④ Pulse test: Pulse width < 380µs, duty cycle < 2%
⑤ $C_{o(cr)}$ is defined as a fixed capacitance with the same stored charge as C_{oes} with V_{CE} = 67% of $V_{(BR)CES}$.
⑥ $C_{o(er)}$ is defined as a fixed capacitance with the same stored energy as C_{oes} with V_{CE} = 67% of $V_{(BR)CES}$. To calculate $C_{o(er)}$ for any value of V_{CE} less than $V_{(BR)CES}$, use this equation: $C_{o(er)}$ = -1.40E-7/V_{DS}^2 + 1.47E-8/V_{DS} + 5.95E-11.
⑦ R_G is external gate resistance, not including internal gate resistance or gate driver impedance (MIC4452).
⑧ E_{on1} is the inductive turn-on energy of the IGBT only, without the effect of a commutating diode reverse recovery current adding to the IGBT turn-on switching loss. It is measured by clamping the inductance with a Silicon Carbide Schottky diode.
⑨ E_{on2} is the inductive turn-on energy that includes a commutating diode reverse recovery current in the IGBT turn-on energy.
⑩ Eoff is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1.

Microsemi reserves the right to change, without notice, the specifications and information contained herein.

ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

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

Symbol	Characteristic / Test Conditions	APT30GS60B_SRDQ2(G)	Unit
$I_{F(AV)}$	Maximum Average Forward Current (T_C = 103°C, Duty Cycle = 0.5)	30	Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)	43	
I_{FSM}	Non-Repetitive Forward Surge Current (T_J = 45°C, 8.3 ms)	210	

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions		Min	Type	Max	Unit
V_F	Forward Voltage	I_F = 30A		2.8	3.3	Volts
		I_F = 60A		3.4		
		I_F = 30A, T_J = 125°C		2.1		

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	-	26	-	ns
t_{rr}	Reverse Recovery Time	I_F = 30A, di_F/dt = -200A/µs V_R = 667V, T_C = 25°C	-	320	-	
Q_{rr}	Reverse Recovery Charge		-	545	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 30A, di_F/dt = -200A/µs V_R = 667V, T_C = 125°C	-	435	-	ns
Q_{rr}	Reverse Recovery Charge		-	2100	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	9	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 30A, di_F/dt = -1000A/µs V_R = 800V, T_C = 125°C	-	180	-	ns
Q_{rr}	Reverse Recovery Charge		-	2975	-	nC
I_{RRM}	Maximum Reverse Recovery Current		-	28	-	Amps

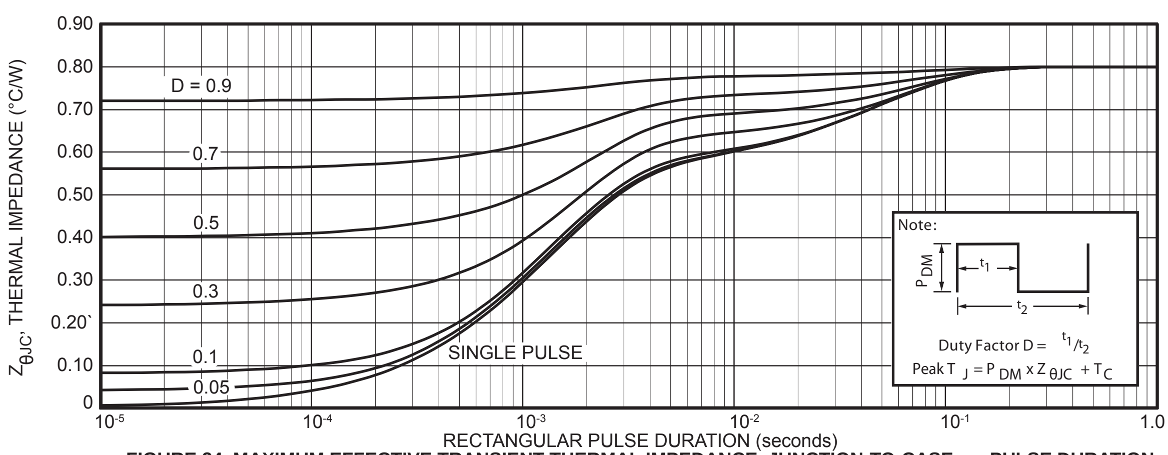


FIGURE 24. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

052-6302 Rev B 3-2012

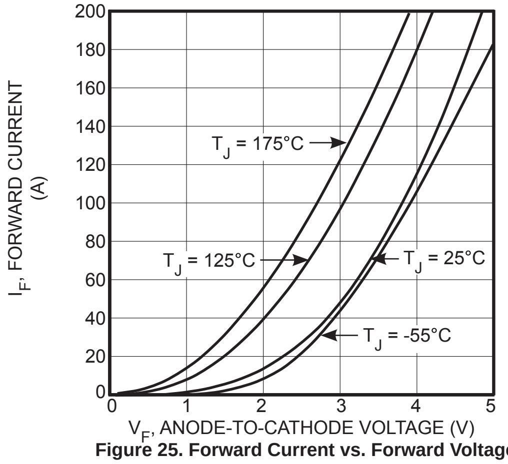


Figure 25. Forward Current vs. Forward Voltage

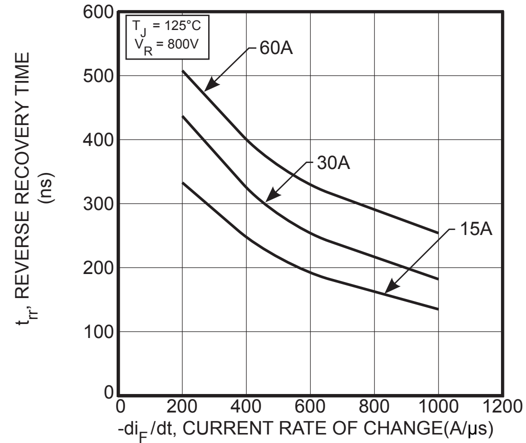


Figure 26. Reverse Recovery Time vs. Current Rate of Change

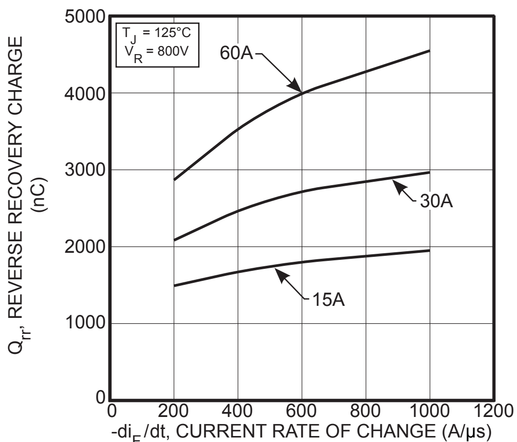


Figure 27. Reverse Recovery Charge vs. Current Rate of Change

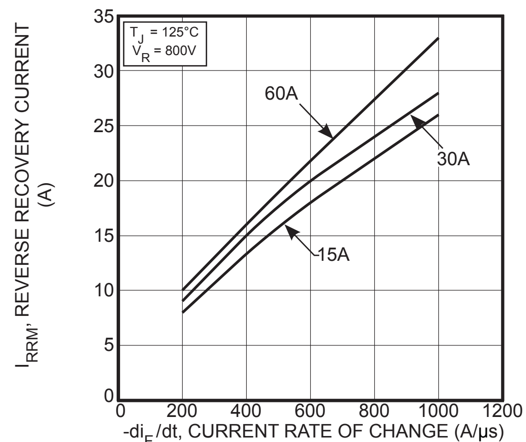


Figure 28. Reverse Recovery Current vs. Current Rate of Change

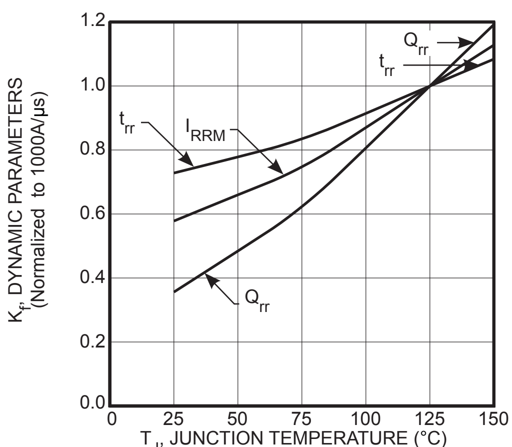


Figure 29. Dynamic Parameters vs. Junction Temperature

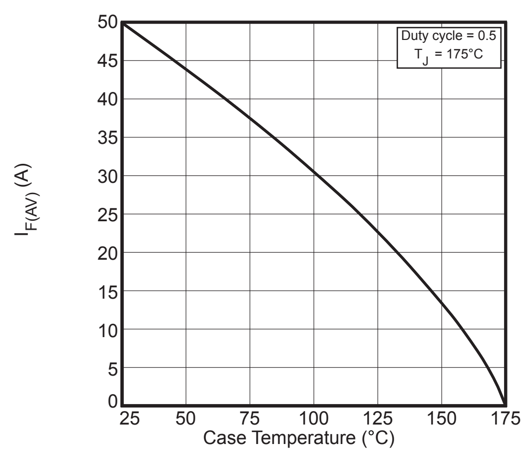


Figure 30. Maximum Average Forward Current vs. CaseTemperature

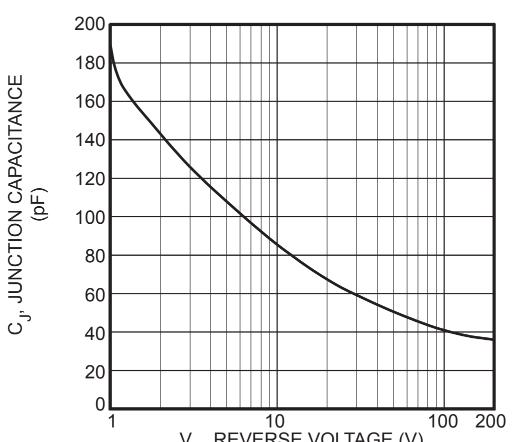


Figure 31. Junction Capacitance vs. Reverse Voltage

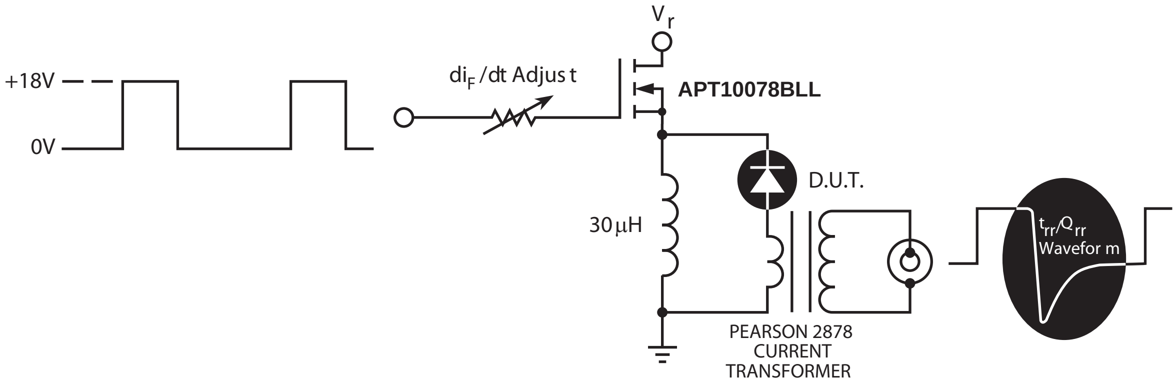


Figure 32. Diode Test Circuit

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 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}.

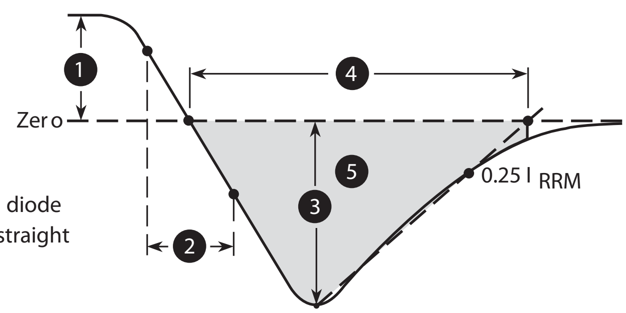
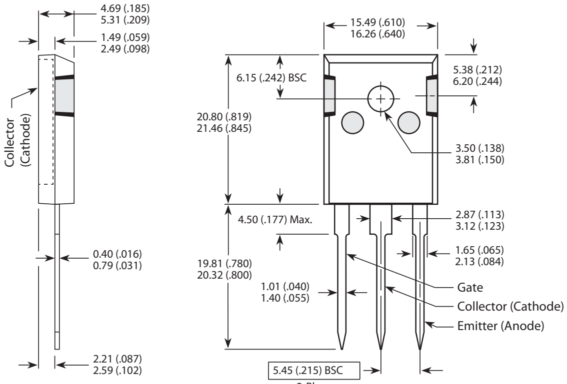


Figure 33, Diode Reverse Recovery Waveform and Definitions

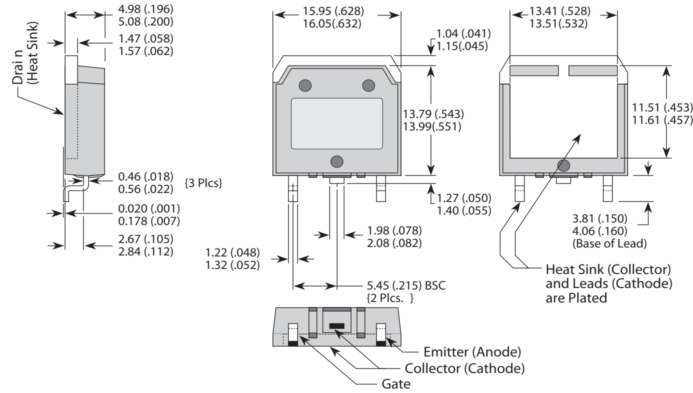
TO-247 Package Outline

D^3 Pak Package Outline

e1 SAC: Tin, Silver, Copper



Dimensions in Millimeters and (Inches)



Dimensions in Millimeters (Inches)