Microsemi
POWER PRODUCTS GROUP

Thunderbolt HS™

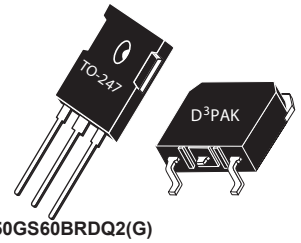
APT50GS60BRDQ2(G)
APT50GS60SRDQ2(G)

600V, 50A, $V_{CE(ON)}$ = 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.



APT50GS60BRDQ2(G)
APT50GS60SRDQ2(G)

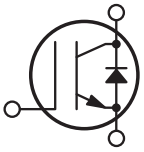
Features

- **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		93	A
I_{C1}	Continuous Collector Current T_C = @ 100°C		50	
I_{CM}	Pulsed Collector Current ①		195	
V_{GE}	Gate-Emitter Voltage		±30V	V
SSOA	Switching Safe Operating Area		195	
E_{AS}	Single Pulse Avalanche Energy		20	mJ
t_{SC}	Short Circut Withstand Time③		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		195	

Thermal and Mechanical Characteristics

Symbol	Parameter		Min	Typ	Max	Unit
P_D	Total Power Dissipation T_C = @ 25°C				415	W
$R_{\theta JC}$	Junction to Case Thermal Resistance	IGBT			0.30	°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 **APT50GS60B_SRDQ2(G)**

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(CES)}$	Collector-Emitter Breakdown Voltage	V_{GE} = 0V, I_C = 2.0mA		600			V
$\Delta V_{BR(CES)}/\Delta T_J$	Breakdown Voltage Temperature Coeff	Reference to 25°C, I_C = 2.0mA			0.60		V/°C
$V_{CE(ON)}$	Collector-Emitter On Voltage③	V_{GE} = 15V, I_C = 50A	T_J = 25°C		2.8	3.15	V
			T_J = 125°C		3.25		
V_{EC}	Diode Forward Voltage③	I_C = 50A	T_J = 25°C		2.15		
			T_J = 125°C		1.8		
$V_{GE(th)}$	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 = 50A		31		S
C_{ies}	Input Capacitance	V_{GE} = 0V, V_{CE} = 25V f = 1MHz		2635		pF
C_{oes}	Output Capacitance			240		
C_{res}	Reverse Transfer Capacitance			145		
$C_{o(cr)}$	Reverse Transfer Capacitance Charge Related ④	V_{GE} = 0V, V_{CE} = 0 to 400V		115		
$C_{o(er)}$	Reverse Transfer Capacitance Current Related ⑤			85		
Q_g	Total Gate Charge	V_{GE} = 0 to 15V, I_C = 50A, V_{CE} = 300V		235		nC
Q_{ge}	Gate-Emitter Charge			18		
G_{gc}	Gate-Collector Charge			100		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching IGBT and Diode: T_J = 25°C, V_{CC} = 400V, I_C = 50A, R_G = 4.7Ω⑥, V_{GG} = 15V		16		ns
t_r	Rise Time			33		
$t_{d(off)}$	Turn-Off Delay Time			225		
t_f	Fall Time			37		
E_{on1}	Turn-On Switching Energy ⑦			TBD		mJ
E_{on2}	Turn-On Switching Energy ⑧			1.2		
E_{off}	Turn-Off Switching Energy ⑨			0.755		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching IGBT and Diode: T_J = 125°C, V_{CC} = 400V, I_C = 50A, R_G = 4.7Ω⑥, V_{GG} = 15V		33		ns
t_r	Rise Time			33		
$t_{d(off)}$	Turn-Off Delay Time			250		
t_f	Fall Time			23		
E_{on1}	Turn-On Switching Energy ⑦			TBD		mJ
E_{on2}	Turn-On Switching Energy ⑧			1.7		
E_{off}	Turn-Off Switching Energy ⑨			0.950		
t_{rr}	Diode Reverse Recovery Time	I_F = 50A, 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

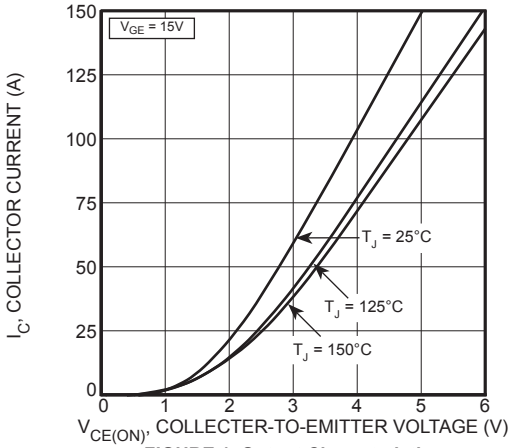


FIGURE 1, Output Characteristics

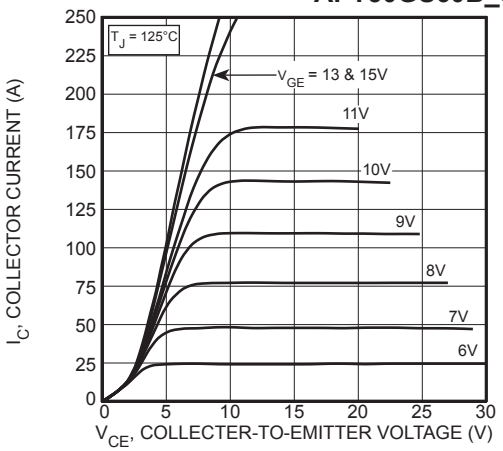


FIGURE 2, Output Characteristics

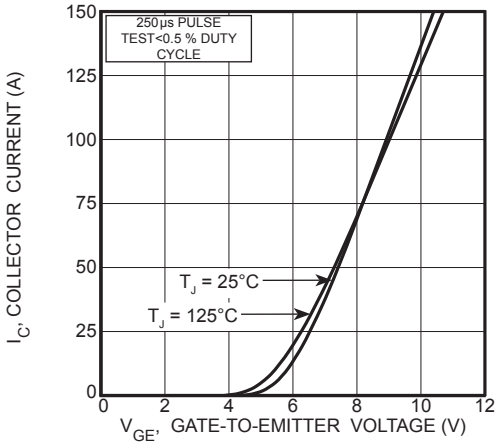


FIGURE 3, Transfer Characteristics

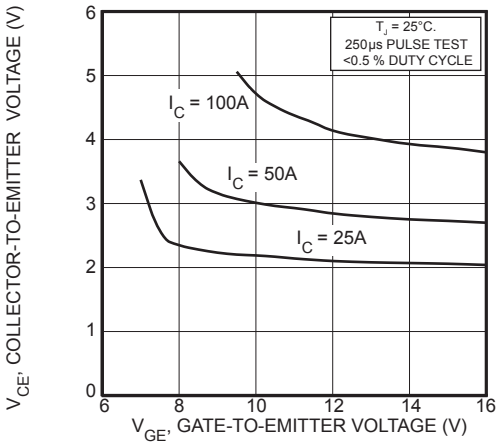


FIGURE 4, On State Voltage vs Gate-to- Emitter Voltage

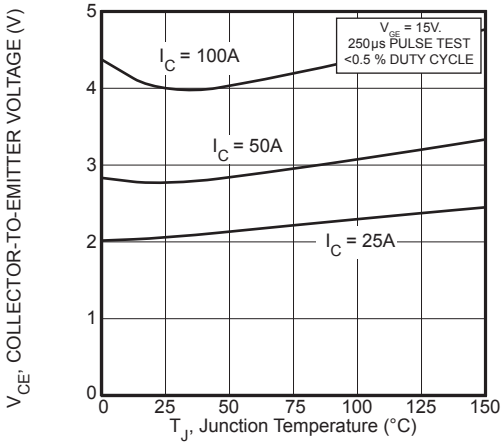


FIGURE 5, On State Voltage vs Junction Temperature

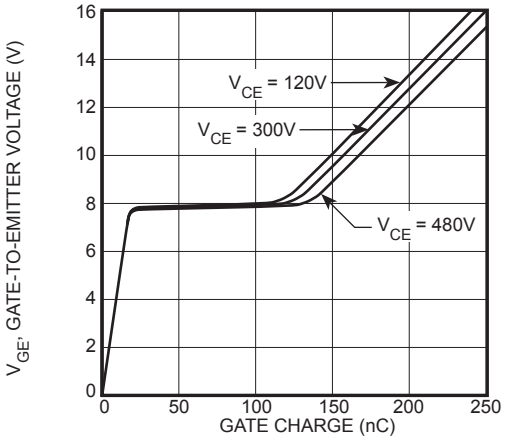


FIGURE 6, Gate Charge

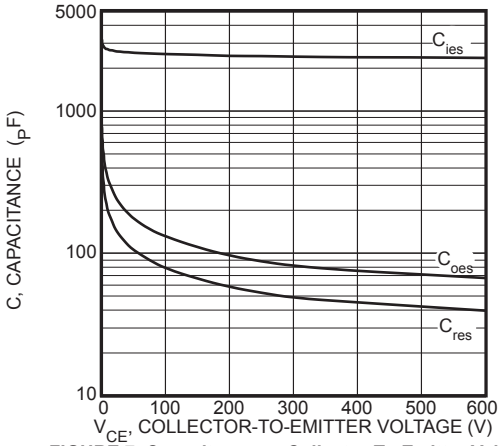


FIGURE 7, Capacitance vs Collector-To-Emitter Voltage

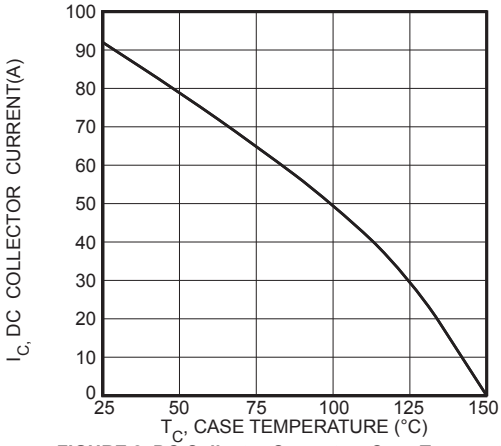


FIGURE 8, DC Collector Current vs Case Temperature

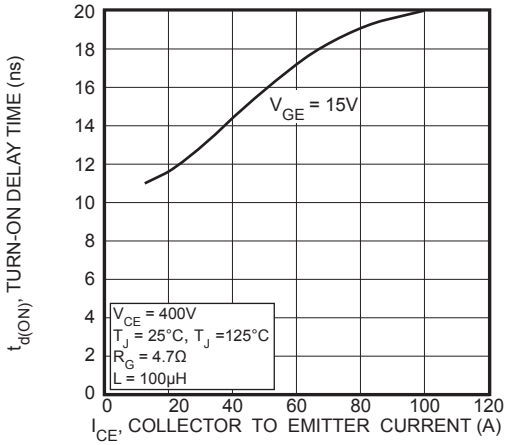


FIGURE 9, Turn-On Delay Time vs Collector Current

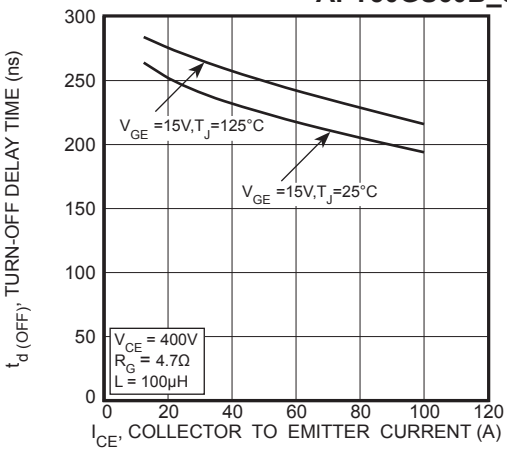


FIGURE 10, Turn-Off Delay Time vs Collector Current

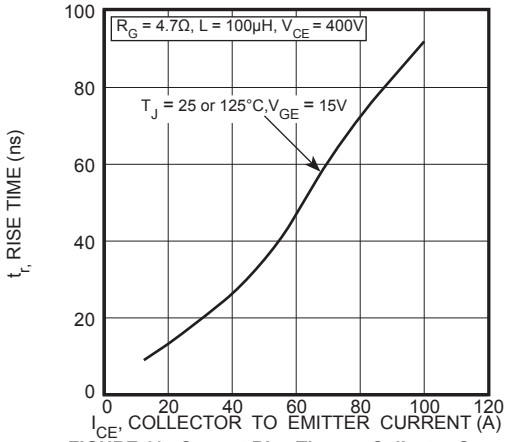


FIGURE 11, Current Rise Time vs Collector Current

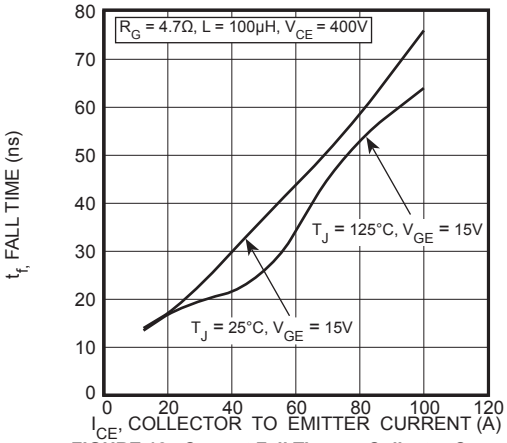


FIGURE 12, Current Fall Time vs Collector Current

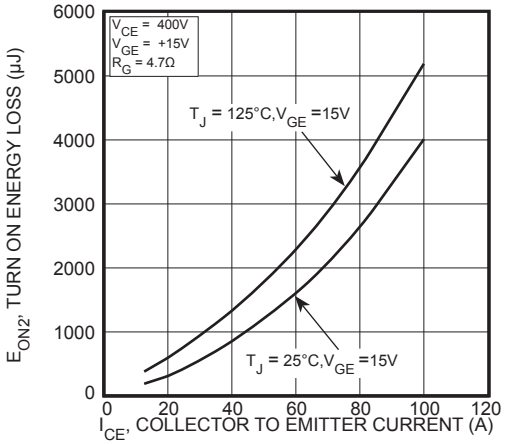


FIGURE 13, Turn-On Energy Loss vs Collector Current

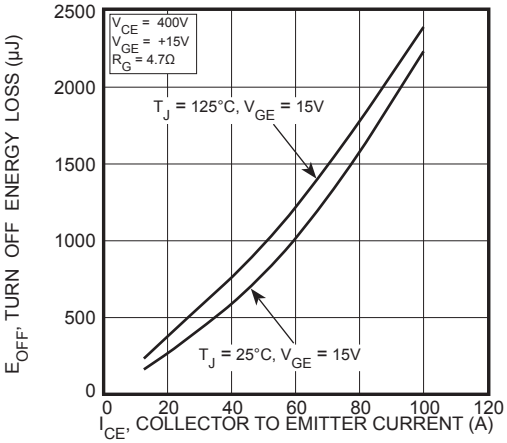


FIGURE 14, Turn Off Energy Loss vs Collector Current

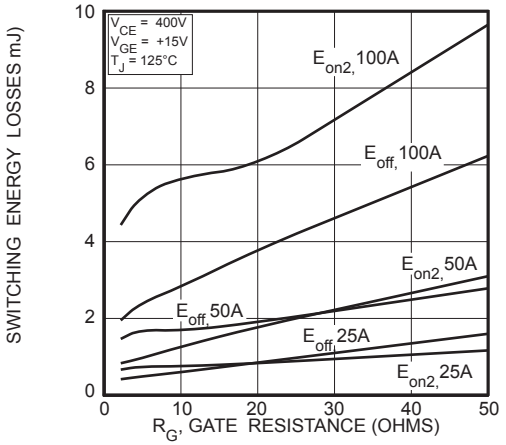


FIGURE 15, Switching Energy Losses vs. Gate Resistance

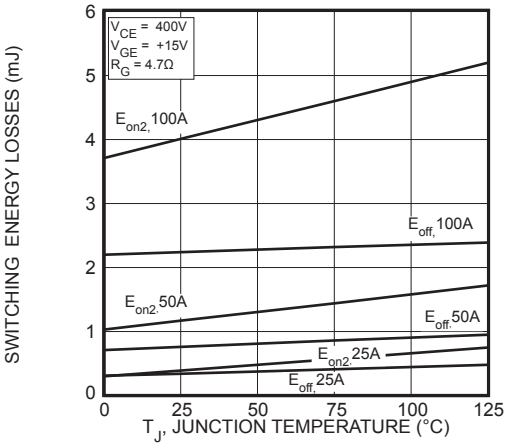


FIGURE 16, Switching Energy Losses vs Junction Temperature

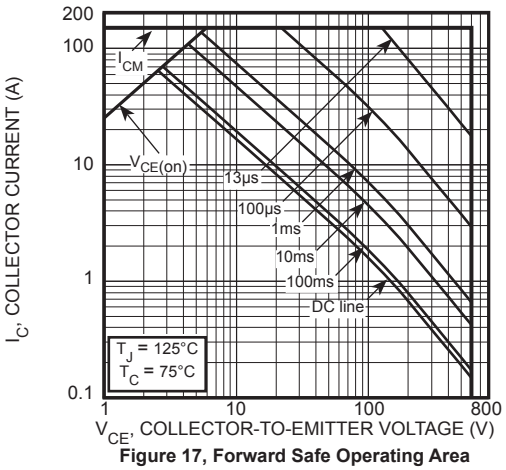


Figure 17, Forward Safe Operating Area

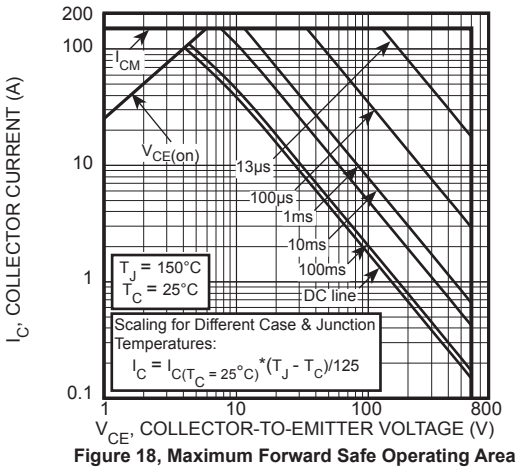


Figure 18, Maximum Forward Safe Operating Area

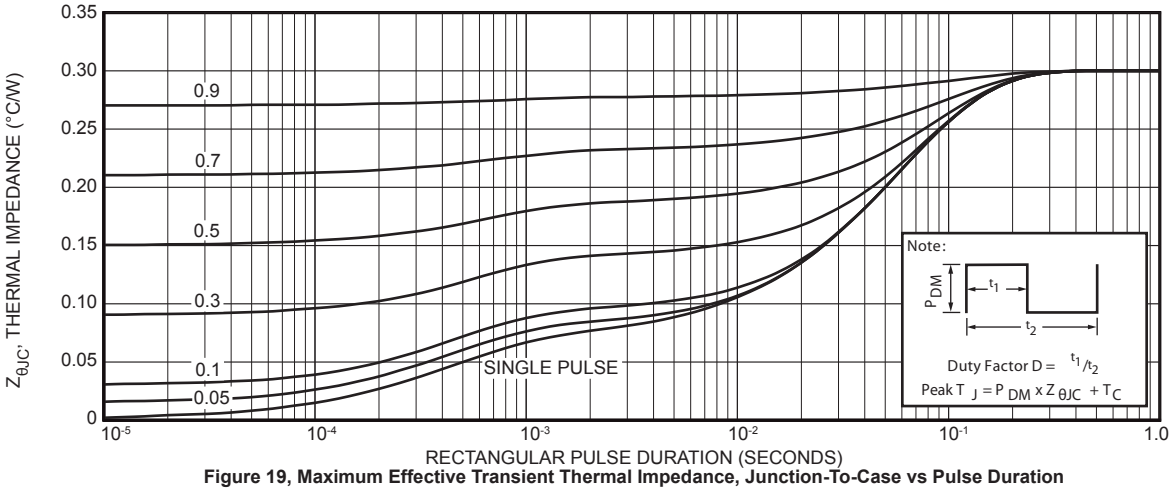
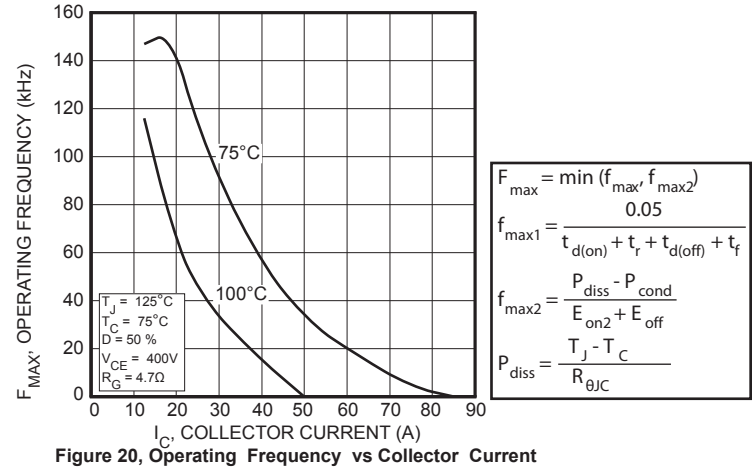


Figure 19, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration



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

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

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

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

Figure 20, Operating Frequency vs Collector Current

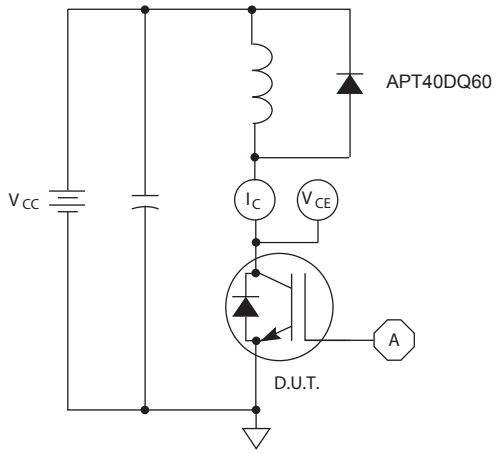


Figure 21, Inductive Switching Test Circuit

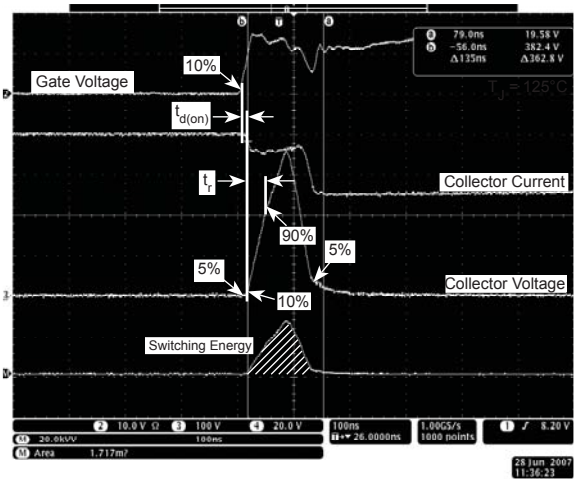


Figure 22, Turn-on Switching Waveforms and Definitions

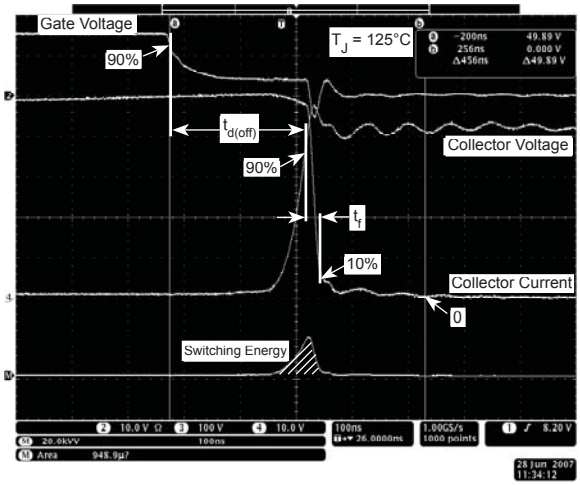


Figure 23, Turn-off Switching Waveforms and Definitions

FOOT NOTE:

① Repetitive Rating: Pulse width and case temperature limited by maximum junction temperature.
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: $C_{o(er)}$ = 5.57E-8/V_{DS}^2 + 7.15E-8/V_{DS} + 2.75E-10.
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	APT50GS60B2RDQ2(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

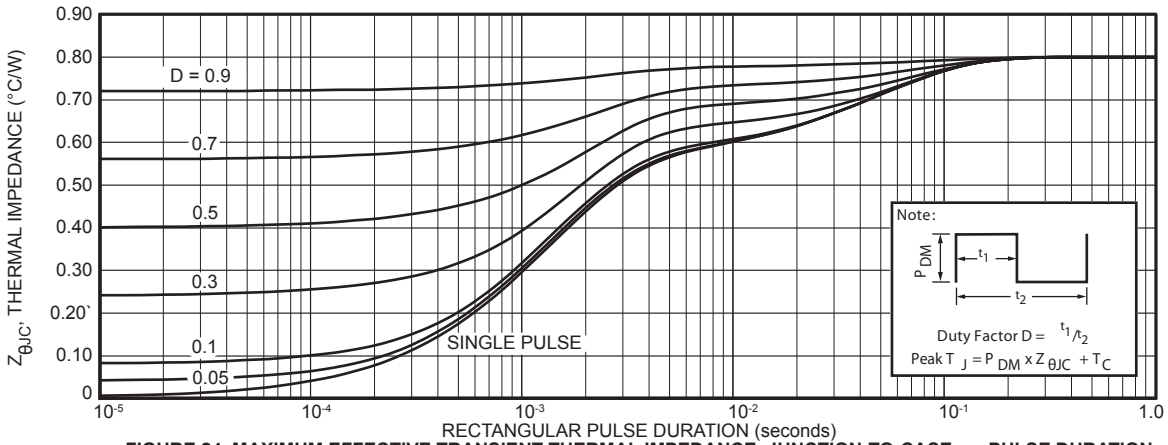


FIGURE 24. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

052-6300 Rev B 3-2012

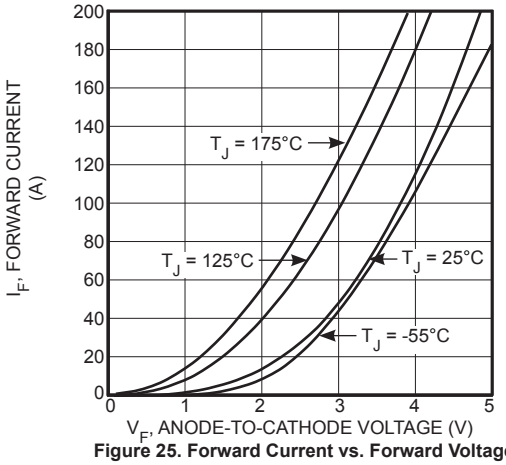


Figure 25. Forward Current vs. Forward Voltage

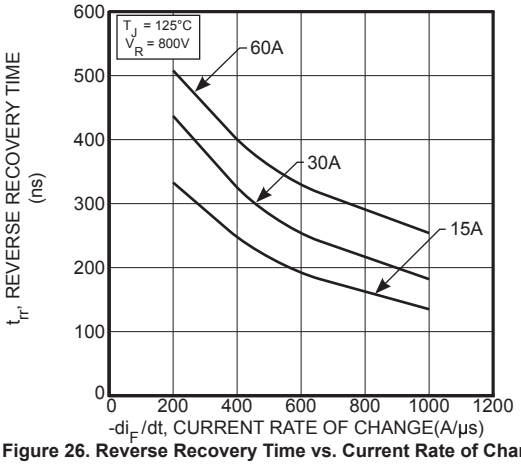


Figure 26. Reverse Recovery Time vs. Current Rate of Change

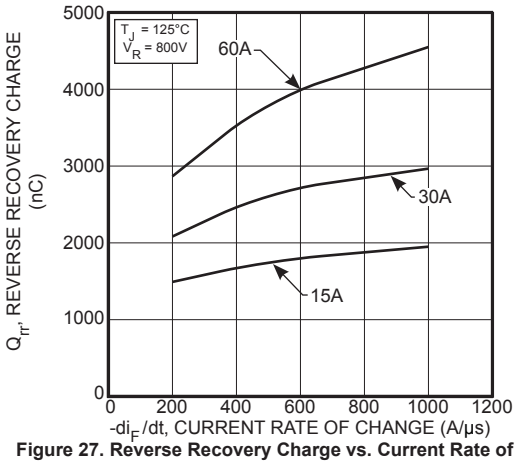


Figure 27. Reverse Recovery Charge vs. Current Rate of Change

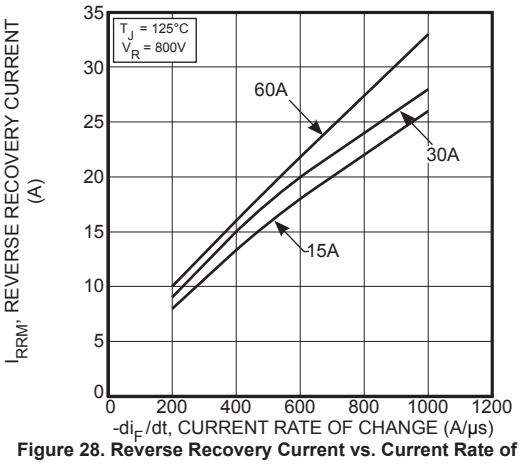


Figure 28. Reverse Recovery Current vs. Current Rate of Change

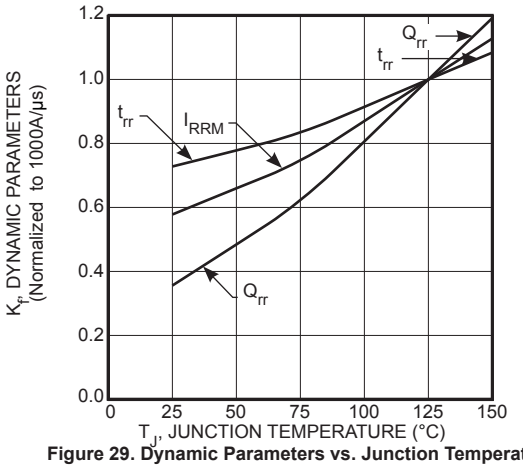


Figure 29. Dynamic Parameters vs. Junction Temperature

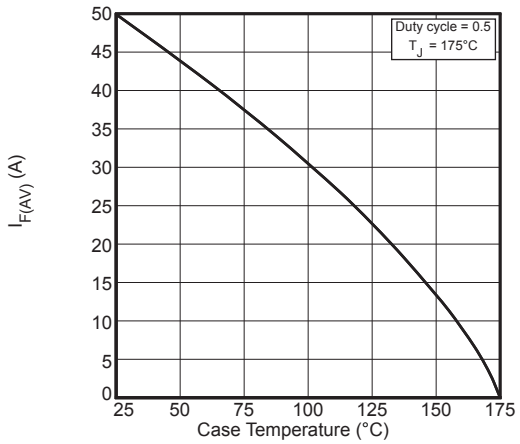


Figure 30. Maximum Average Forward Current vs. CaseTemperature

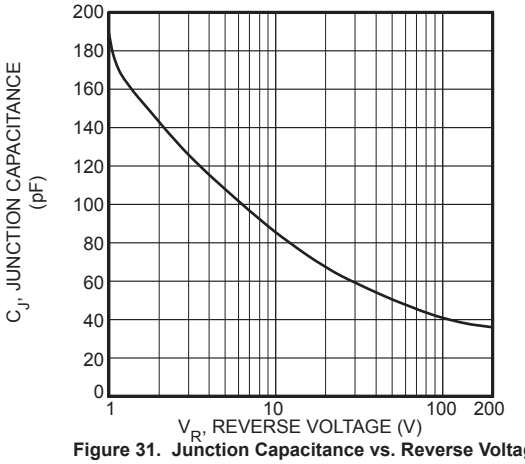


Figure 31. Junction Capacitance vs. Reverse Voltage

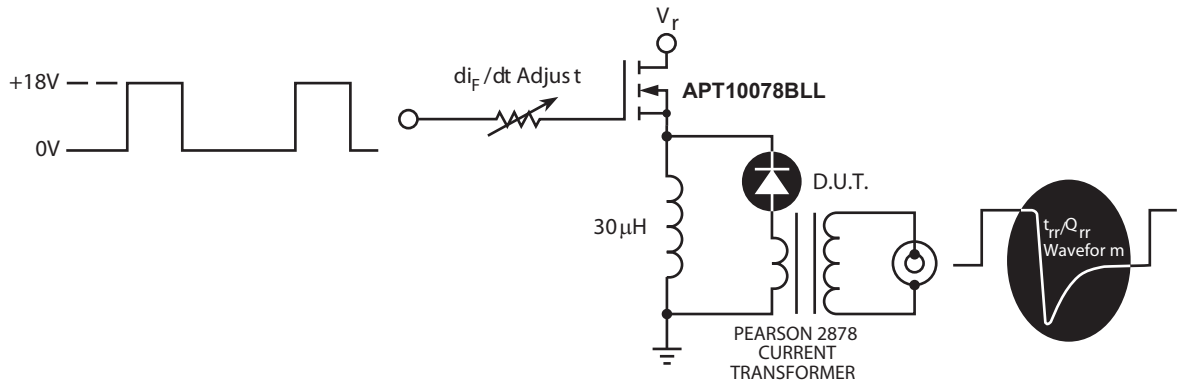


Figure 32. Diode Test Circuit

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}.

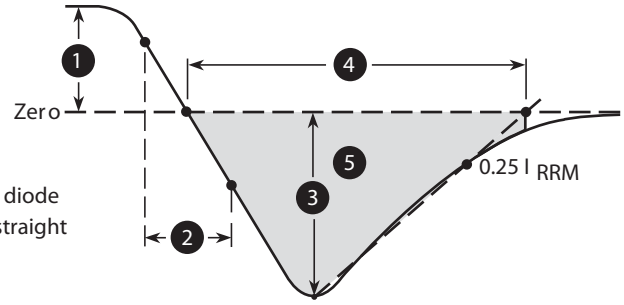
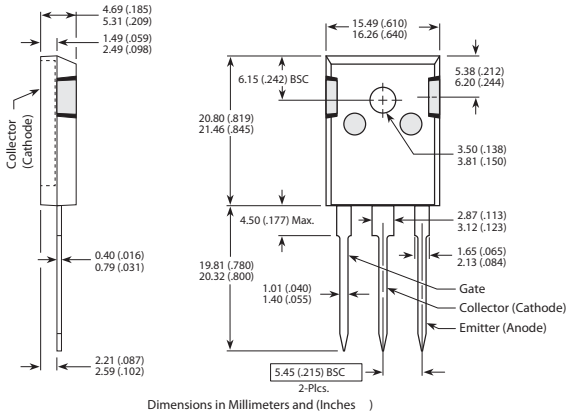


Figure 33. Diode Reverse Recovery Waveform Definitions

TO-247 Package Outline

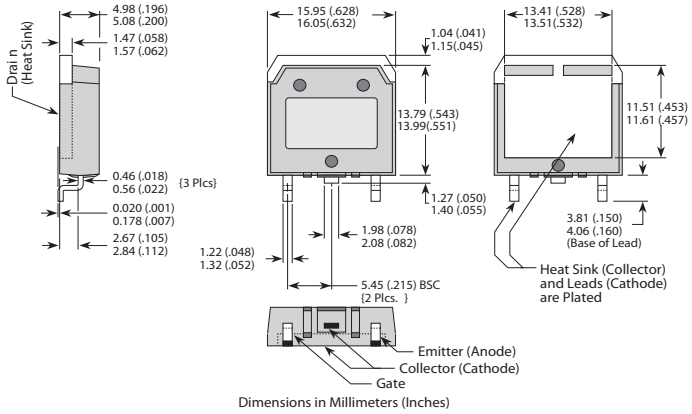
e1 SAC: Tin, Silver, Copper



Dimensions in Millimeters and (Inches)

D³ Pak Package Outline

e3 SAC: Tin, Silver, Copper



Dimensions in Millimeters (Inches)

ENTEGRECİ

Bu belge www.entegreci.com üzerinden sunulmaktadır.

Elektronik komponent tedarikinde Entegreci

Entegreci, Eskişehir merkezli, Türkiye geneline satış yapan bir elektronik komponent mağazasıdır. Entegreler (IC), mikrodenetleyiciler, transistörler, diyotlar, pasif elemanlar, konnektörler, modüller ve geliştirme kartları tek adetten seri üretim adetlerine kadar satılır. Ürün sayfalarında güncel stok durumunu, fiyatı ve datasheet bağlantısını bulabilirsiniz.

Parça koduyla arama

Üretici parça numarasını yazın; stok ve fiyatı hemen görün.

www.entegreci.com

Ürün kategorileri

Entegreden kapasitöre tüm elektronik komponent kategorileri.

Kategorilere göz atın

Üreticiler

Aradığınız üreticinin ürünlerini tek sayfada inceleyin.

Üreticileri görün

Toplu alım ve teklif

Listede olmayan ya da yüksek adetli parçalar için teklif isteyin.

Teklif isteyin

www.entegreci.com | **destek@entegreci.com** | **0850 305 90 34**

Entegreci is an online electronic components store based in Türkiye. Search by manufacturer part number to see stock, prices and datasheets for integrated circuits, microcontrollers, transistors, passive components and connectors, or request a quote for parts that are not listed.

Bu sayfa Entegreci tarafından eklenmiştir. Belgenin önceki sayfaları asıl yayıncısına aittir ve içeriği değiştirilmemiştir; en güncel sürüm için belgenin yayıncısına başvurun.