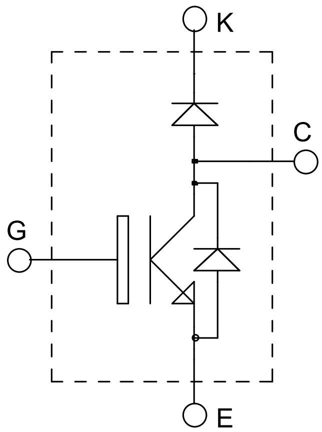
APT60GF60JU2

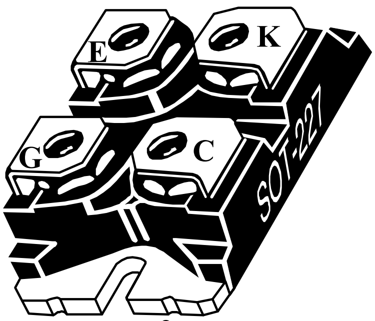
ISOTOP® Boost chopper NPT IGBT

V_{CES} = 600V
I_C = 60A @ Tc = 95°C



Application
- AC and DC motor control
- Switched Mode Power Supplies
- Power Factor Correction
- Brake switch

Features
- Non Punch Through (NPT) THUNDERBOLT IGBT
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 100 kHz
  - Soft recovery parallel diodes
  - Low diode VF
  - Low leakage current
  - Avalanche energy rated
  - RBSOA and SCSOA rated
- ISOTOP® Package (SOT-227)
- Very low stray inductance
- High level of integration



ISOTOP®

Benefits
- Outstanding performance at high frequency operation
- Stable temperature behavior
- Very rugged
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Easy paralleling due to positive T_C of V_{CEsat}
- RoHS Compliant

Absolute maximum ratings

Symbol	*Parameter*			*Max ratings*	*Unit*
V_{CES}	Collector - Emitter Breakdown Voltage			600	V
I_{C1}	Continuous Collector Current		T_C = 25°C	93	A
I_{C2}			T_C = 95°C	60	
I_{CM}	Pulsed Collector Current		T_C = 25°C	360	
V_{GE}	Gate – Emitter Voltage			±20	V
P_D	Maximum Power Dissipation		T_C = 25°C	378	W
I_{LM}	RBSOA clamped Inductive load Current R_G=11Ω		T_C = 25°C	360	A
IF_{AV}	Maximum Average Forward Current	Duty cycle=0.5	T_C = 80°C	30	A
IF_{RMS}	RMS Forward Current (Square wave, 50% duty)			39	

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

All ratings @ T_j = 25°C unless otherwise specified

Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{CES}	Zero Gate Voltage Collector Current	V_{GE} = 0V V_{CE} = 600V	T_j = 25°C			80	µA
			T_j = 125°C			2000	
$V_{CE(sat)}$	Collector Emitter saturation Voltage	V_{GE} =15V I_C = 60A	T_j = 25°C		2.0	2.5	V
			T_j = 125°C			2.8	
$V_{GE(th)}$	Gate Threshold Voltage	V_{GE} = V_{CE}, I_C = 500µA		3	4	5	V
I_{GES}	Gate – Emitter Leakage Current	V_{GE} = ±20V, V_{CE} = 0V				±100	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{ies}	Input Capacitance	V_{GE} = 0V V_{CE} = 25V f = 1MHz		3125	3590	pF
C_{oes}	Output Capacitance			310	450	
C_{res}	Reverse Transfer Capacitance			180	310	
Q_g	Total gate Charge	V_{GS} = 15V V_{Bus} = 300V I_C = 60A		257	410	nC
Q_{ge}	Gate – Emitter Charge			19	30	
Q_{gc}	Gate – Collector Charge			120	180	
$T_{d(on)}$	Turn-on Delay Time	Resistive Switching (25°C) V_{GE} = 15V V_{Bus} = 300V I_C = 60A R_G = 5Ω		20	40	ns
T_r	Rise Time			95	190	
$T_{d(off)}$	Turn-off Delay Time			315	470	
T_f	Fall Time			245	490	
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = 15V V_{Bus} = 400V I_C = 60A R_G = 5Ω		26	50	ns
T_r	Rise Time			63	125	
$T_{d(off)}$	Turn-off Delay Time			395	590	
T_f	Fall Time			68	140	
E_{ts}	Total switching Losses			3.4	7	mJ
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (150°C) V_{GE} = 15V V_{Bus} = 400V I_C = 60A R_G = 5Ω		25	50	ns
T_r	Rise Time			59	120	
$T_{d(off)}$	Turn-off Delay Time			430	650	
T_f	Fall Time			65	130	
E_{on}	Turn-on Switching Energy			1.6	3.2	mJ
E_{off}	Turn-off Switching Energy			2.4	4.8	
E_{ts}	Total switching Losses			4.0	8.0	

Chopper diode ratings and characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_F	Diode Forward Voltage	I_F = 30A			1.6	1.8	V
		I_F = 60A			1.9		
		I_F = 30A	T_j = 125°C		1.4		
I_{RM}	Maximum Reverse Leakage Current	V_R = 600V	T_j = 25°C			250	µA
		V_R = 600V	T_j = 125°C			500	
C_T	Junction Capacitance	V_R = 200V			44		pF
t_{rr}	Reverse Recovery Time	I_F=1A,V_R=30V di/dt =100A/µs	T_j = 25°C		23		ns
	Reverse Recovery Time	I_F = 30A V_R = 400V di/dt =200A/µs	T_j = 25°C		85		
			T_j = 125°C		160		
I_{RRM}	Maximum Reverse Recovery Current		T_j = 25°C		4		A
			T_j = 125°C		8		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		130		nC
			T_j = 125°C		700		
t_{rr}	Reverse Recovery Time	I_F = 30A V_R = 400V di/dt =1000A/µs	T_j = 125°C		70		ns
Q_{rr}	Reverse Recovery Charge				1300		nC
I_{RRM}	Maximum Reverse Recovery Current				30		A

Thermal and package characteristics

Symbol	Characteristic		Min	Typ	Max	Unit
R_{thJC}	Junction to Case Thermal Resistance	IGBT			0.33	°C/W
		Diode			1.21	
R_{thJA}	Junction to Ambient (IGBT & Diode)				20	
V_{ISOL}	RMS Isolation Voltage, any terminal to case t =1 min, 50/60Hz		2500			V
T_J,T_{STG}	Storage Temperature Range		-55		150	°C
T_L	Max Lead Temp for Soldering:0.063” from case for 10 sec				300	
Torque	Mounting torque (Mounting = 8-32 or 4mm Machine and terminals = 4mm Machine)				1.5	N.m
Wt	Package Weight			29.2		g

Typical IGBT Performance Curve

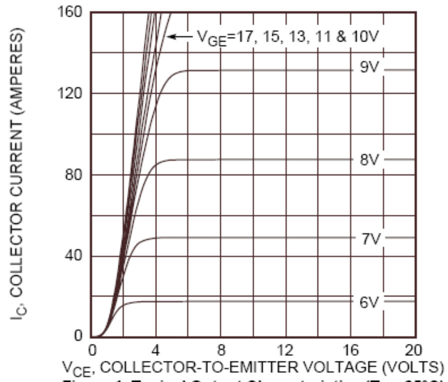


Figure 1, Typical Output Characteristics (T_J = 25°C)

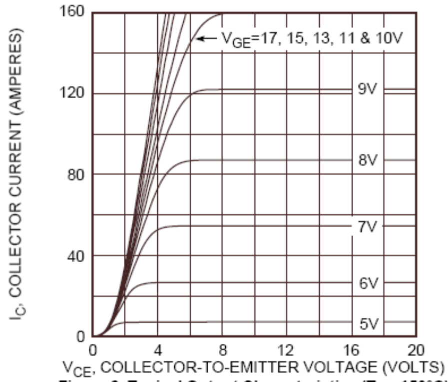


Figure 2, Typical Output Characteristics (T_J = 150°C)

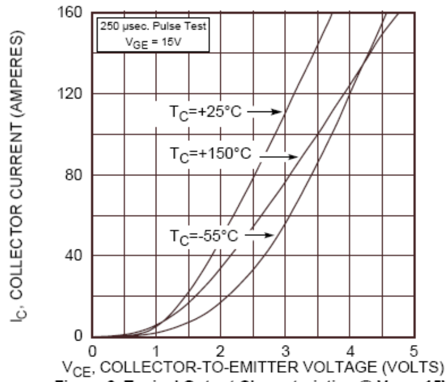


Figure 3, Typical Output Characteristics @ V_{GE} = 15V

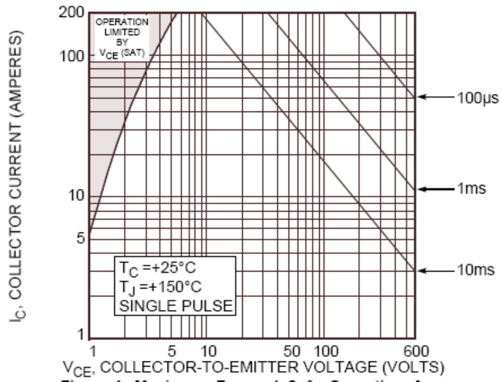


Figure 4, Maximum Forward Safe Operating Area

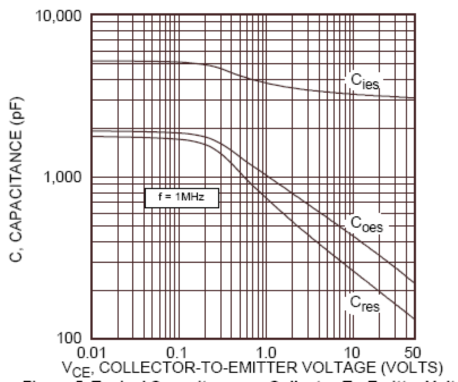


Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

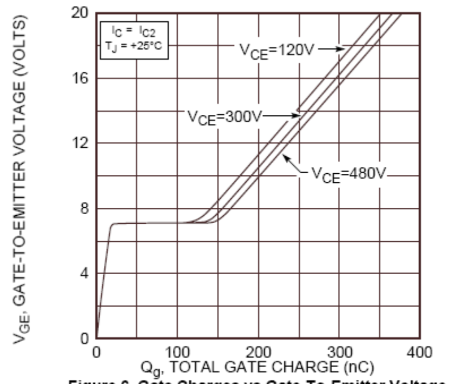


Figure 6, Gate Charges vs Gate-To-Emitter Voltage

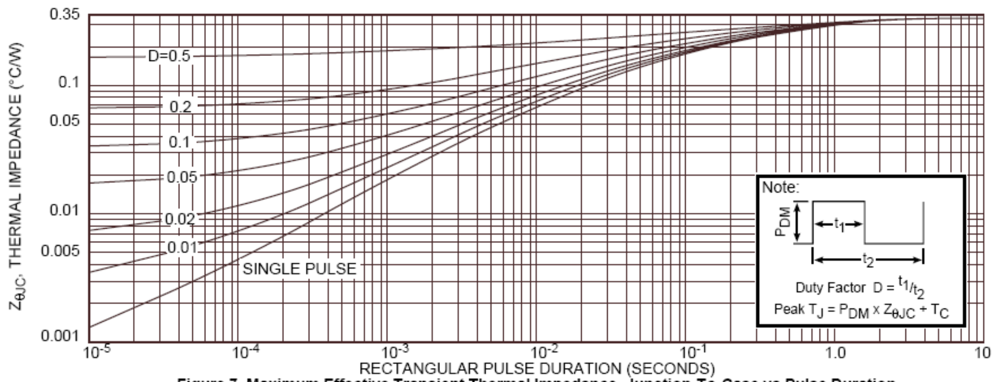


Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

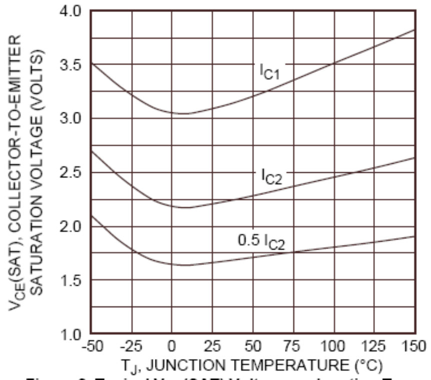


Figure 8, Typical $V_{CE}(SAT)$ Voltage vs Junction Temperature

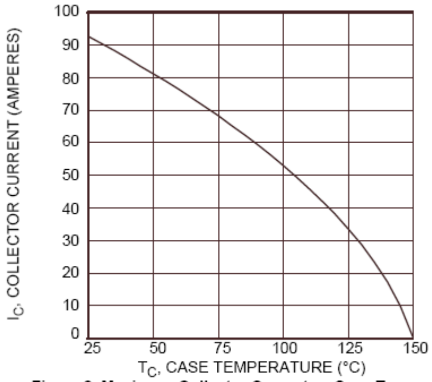


Figure 9, Maximum Collector Current vs Case Temperature

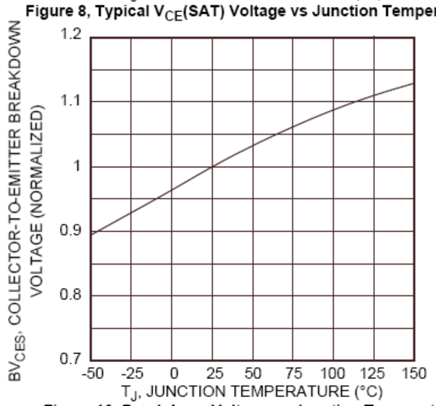


Figure 10, Breakdown Voltage vs Junction Temperature

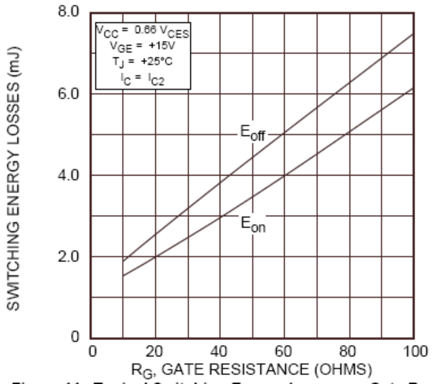


Figure 11, Typical Switching Energy Losses vs Gate Resistance

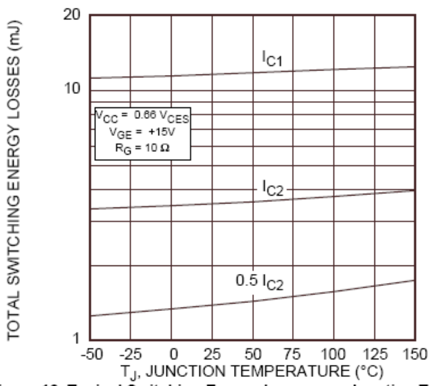


Figure 12, Typical Switching Energy Losses vs. Junction Temperature

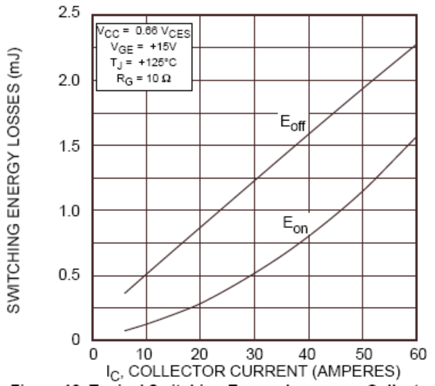


Figure 13, Typical Switching Energy Losses vs Collector Current

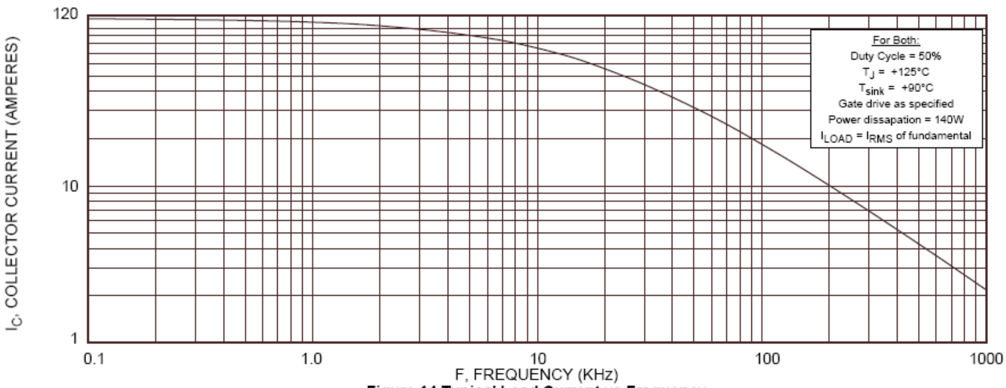


Figure 14,Typical Load Current vs Frequency

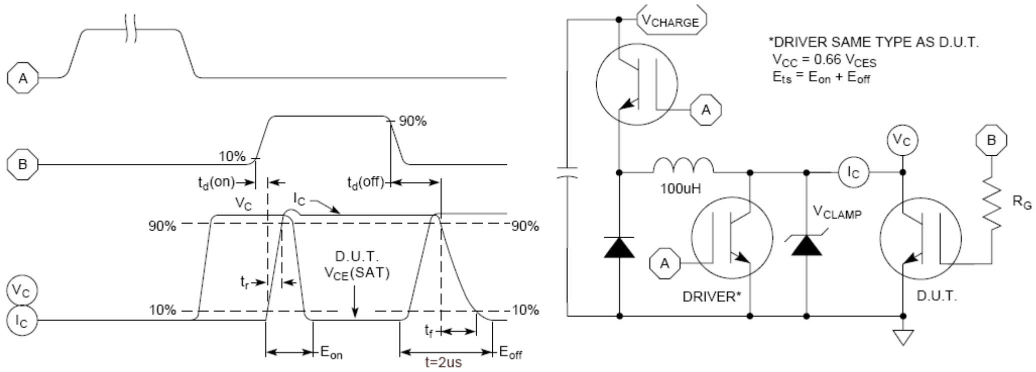


Figure 15, Switching Loss Test Circuit and Waveforms

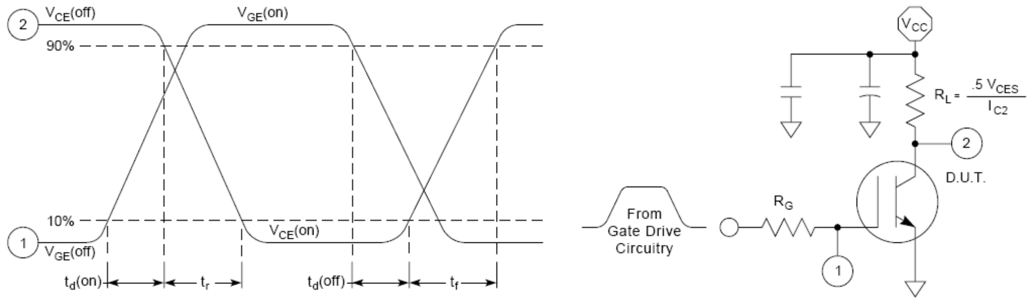


Figure 16, Resistive Switching Time Test Circuit and Waveforms

Typical Diode Performance Curve

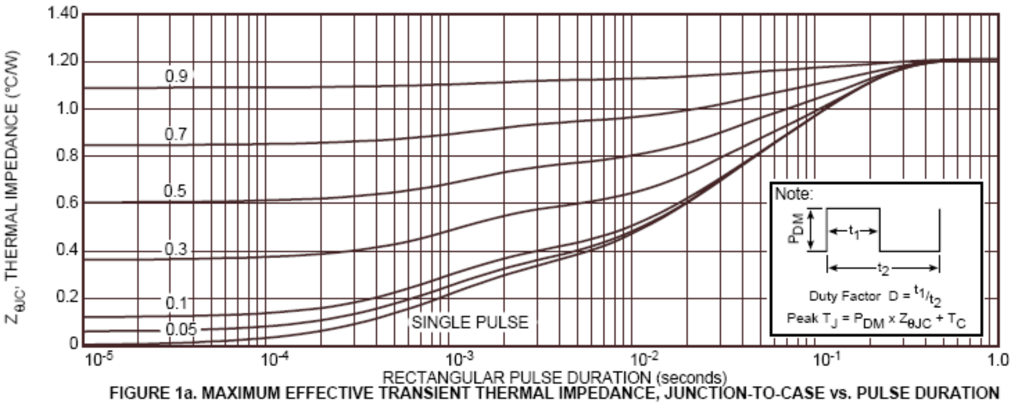


FIGURE 1a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

RC MODEL

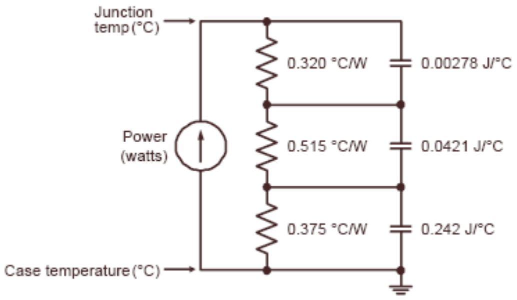


FIGURE 1b, TRANSIENT THERMAL IMPEDANCE MODEL

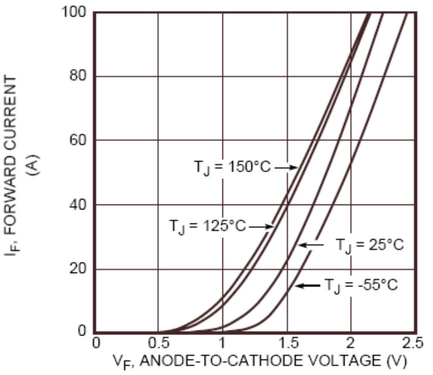


Figure 2. Forward Current *vs.* Forward Voltage

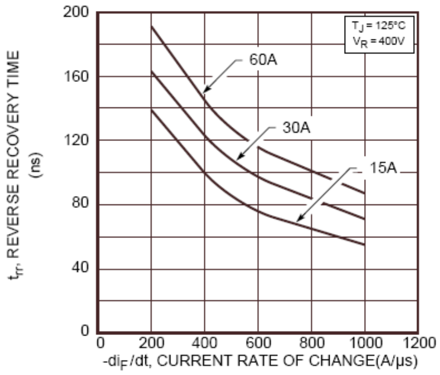


Figure 3. Reverse Recovery Time *vs.* Current Rate of Change

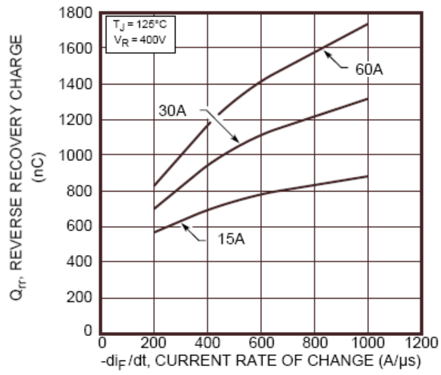


Figure 4. Reverse Recovery Charge *vs.* Current Rate of Change

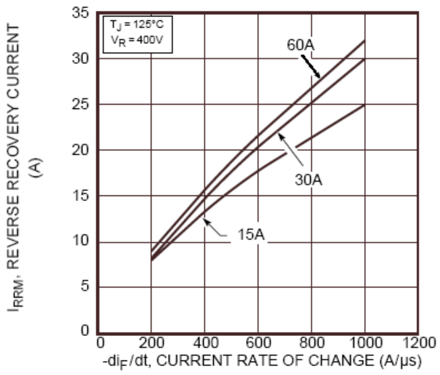


Figure 5. Reverse Recovery Current *vs.* Current Rate of Change

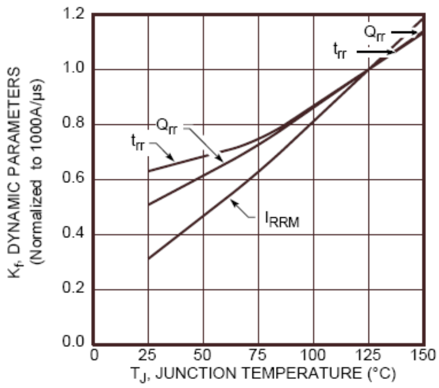


Figure 6. Dynamic Parameters *vs.* Junction Temperature

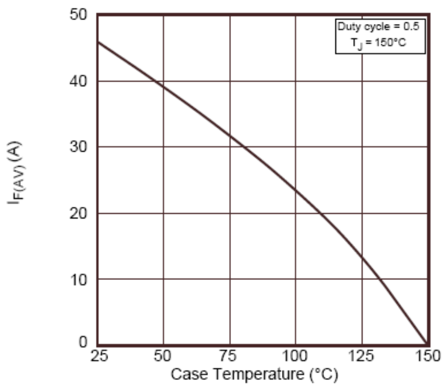


Figure 7. Maximum Average Forward Current *vs.* CaseTemperature

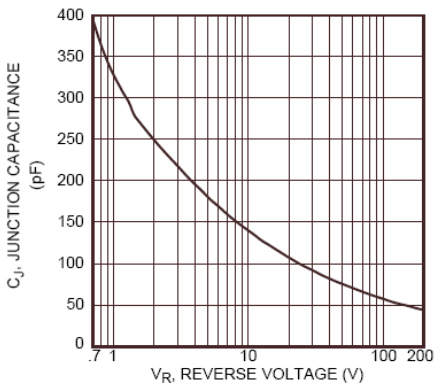


Figure 8. Junction Capacitance *vs.* Reverse Voltage

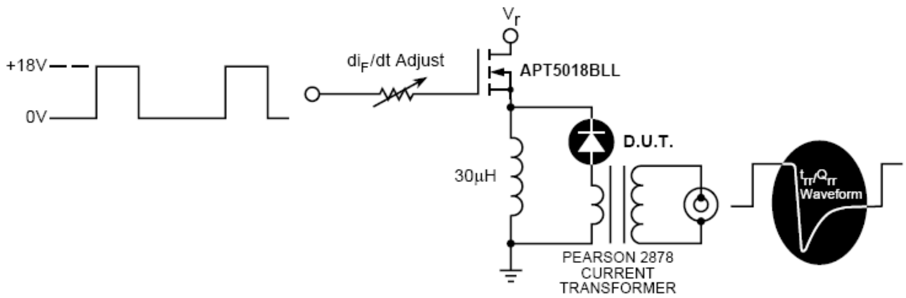


Figure 9. Diode Test Circuit

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 diode current goes from positive to negative, to the point at which the straight line through I_{RRM} and $0.25 \cdot I_{RRM}$ passes through zero.
5. Q_{rr} - Area Under the Curve Defined by I_{RRM} and t_{rr}.

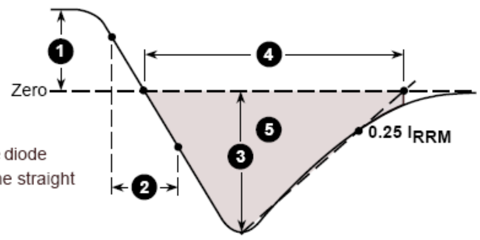
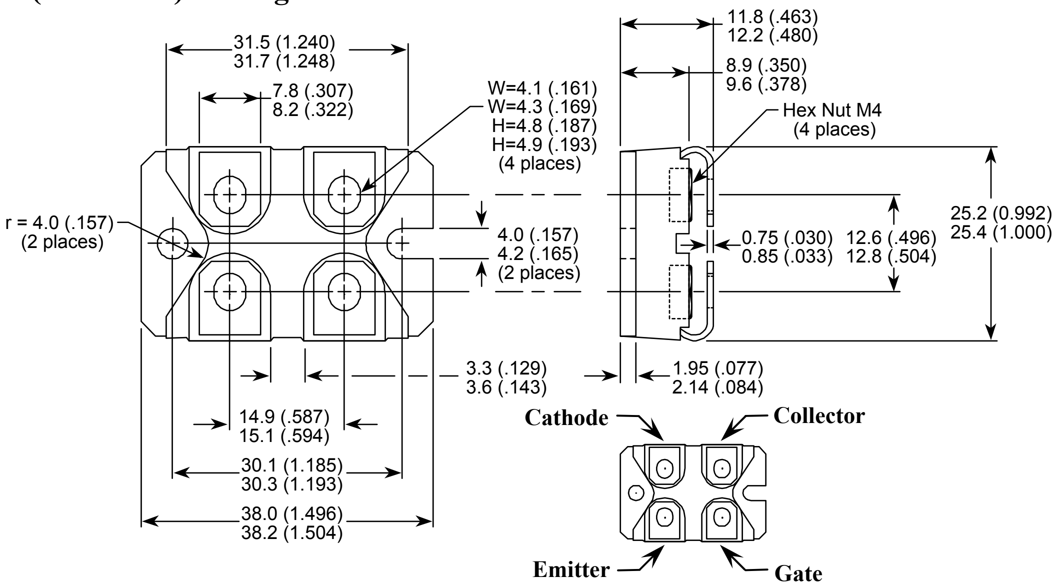


Figure 10, Diode Reverse Recovery Waveform and Definitions

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches)

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