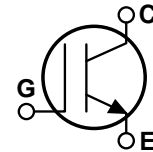
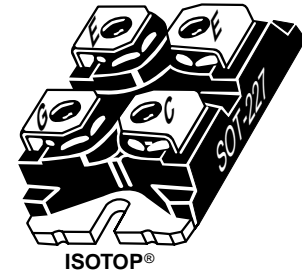


## Thunderbolt IGBT™

The Thunderbolt IGBT™ is a new generation of high voltage power IGBTs. Using Non-Punch Through Technology the Thunderbolt IGBT™ offers superior ruggedness and ultrafast switching speed.

- Low Forward Voltage Drop
- Low Tail Current
- Avalanche Rated
- High Freq. Switching to 150KHz
- Ultra Low Leakage Current
- RBSOA and SCSOA Rated



### MAXIMUM RATINGS

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

Symbol	Parameter	APT60GT60JR	UNIT
$V_{CES}$	Collector-Emitter Voltage	600	Volts
$V_{CGR}$	Collector-Gate Voltage ( $R_{GE} = 20K\Omega$ )	600	
$V_{GE}$	Gate Emitter Voltage	$\pm 20$	
$I_{C1}$	Continuous Collector Current @ $T_C = 25^\circ\text{C}$	93	Amps
$I_{C2}$	Continuous Collector Current @ $T_C = 95^\circ\text{C}$	60	
$I_{CM}$	Pulsed Collector Current <sup>①</sup> @ $T_C = 25^\circ\text{C}$	360	
$I_{LM}$	RBSOA Clamped Inductive Load Current $R_G = 11\Omega$ $T_C = 25^\circ\text{C}$	360	
$E_{AS}$	Single Pule Avalanche Energy <sup>②</sup>	65	mJ
$P_D$	Total Power Dissipation	378	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

Symbol	Characteristic / Test Conditions	MIN	TYP	MAX	UNIT
$BV_{CES}$	Collector-Emitter Breakdown Voltage ( $V_{GE} = 0V, I_C = 0.5mA$ )	600			Volts
$V_{GE(TH)}$	Gate Threshold Voltage ( $V_{CE} = V_{GE}, I_C = 500\mu A, T_j = 25^\circ\text{C}$ )	3	4	5	
$V_{CE(ON)}$	Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = I_{C2}, T_j = 25^\circ\text{C}$ )		2.0	2.5	
	Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = I_{C2}, T_j = 125^\circ\text{C}$ )			2.8	
$I_{CES}$	Collector Cut-off Current ( $V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 25^\circ\text{C}$ )			80	$\mu A$
	Collector Cut-off Current ( $V_{CE} = V_{CES}, V_{GE} = 0V, T_j = 125^\circ\text{C}$ )			2000	
$I_{GES}$	Gate-Emitter Leakage Current ( $V_{GE} = \pm 20V, V_{CE} = 0V$ )			$\pm 100$	nA

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

APT Website - <http://www.advancedpower.com>

<b>USA</b>	405 S.W. Columbia Street	Bend, Oregon 97702-1035	Phone: (541) 382-8028	FAX: (541) 388-0364
<b>EUROPE</b>	Chemin de Magret	F-33700 Merignac - France	Phone: (33) 5 57 92 15 15	FAX: (33) 5 56 47 97 61

## DYNAMIC CHARACTERISTICS

APT60GT60JR

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
$C_{ies}$	Input Capacitance	<b>Capacitance</b> $V_{GE} = 0V$ $V_{CE} = 25V$ $f = 1\text{ MHz}$		3125	3590	pF
$C_{oes}$	Output Capacitance			310	450	
$C_{res}$	Reverse Transfer Capacitance			180	310	
$Q_g$	Total Gate Charge <sup>③</sup>	<b>Gate Charge</b> $V_{GE} = 15V$ $V_{CC} = 0.5V_{CES}$ $I_C = I_{C2}$		257	410	nC
$Q_{ge}$	Gate-Emitter Charge			19	30	
$Q_{gc}$	Gate-Collector ("Miller") Charge			120	180	
$t_{d(on)}$	Turn-on Delay Time	<b>Resistive Switching (25°C)</b> $V_{GE} = 15V$ $V_{CC} = 0.5V_{CES}$ $I_C = I_{C2}$ $R_G = 5\Omega$		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	<b>Inductive Switching (150°C)</b> $V_{CLAMP(Peak)} = 0.66V_{CES}$ $V_{GE} = 15V$ $I_C = I_{C2}$ $R_G = 5\Omega$ $T_J = +150^\circ C$		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	
$E_{off}$	Turn-off Switching Energy		2.4	4.8	mJ	
$E_{ts}$	Total Switching Losses		4.0	8.0		
$t_{d(on)}$	Turn-on Delay Time	<b>Inductive Switching (25°C)</b> $V_{CLAMP(Peak)} = 0.66V_{CES}$ $V_{GE} = 15V$ $I_C = I_{C2}$ $R_G = 5\Omega$ $T_J = +25^\circ C$		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	7.0	
gfe	Forward Transconductance	$V_{CE} = 20V, I_C = I_{C2}$	4			S

## THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to Case			0.33	°C/W
$R_{\theta JA}$	Junction to Ambient			20	
$W_T$	Package Weight		1.03		oz
			29.2		gm
Torque	Mounting Torque (Mounting = 8-32 or 4mm Machine and Terminals = 4mm Machine)			10	lb•in
				1.5	N•m

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

②  $I_C = I_{C2}$ ,  $R_{GE} = 25\Omega$ ,  $L = 100\mu H$ ,  $T_J = 25^\circ C$

③ See MIL-STD-750 Method 3471

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

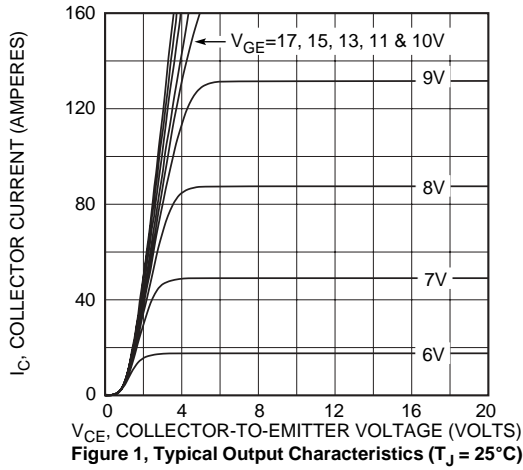


Figure 1, Typical Output Characteristics ( $T_J = 25^\circ\text{C}$ )

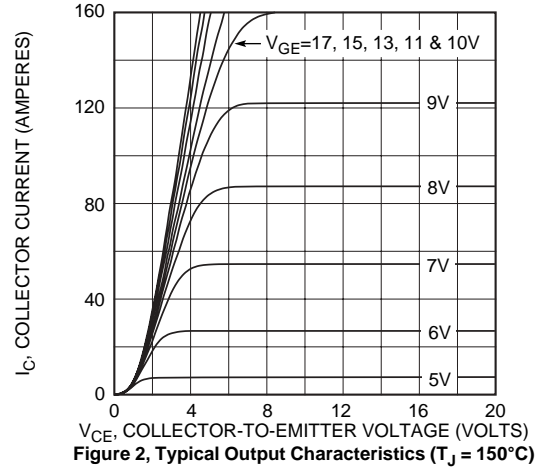


Figure 2, Typical Output Characteristics ( $T_J = 150^\circ\text{C}$ )

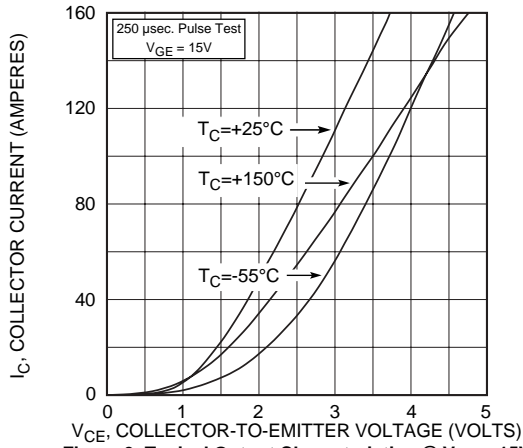


Figure 3, Typical Output Characteristics @  $V_{GE} = 15\text{V}$

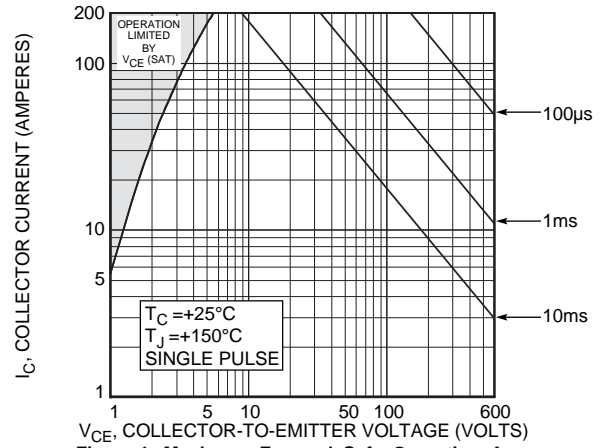


Figure 4, Maximum Forward Safe Operating Area

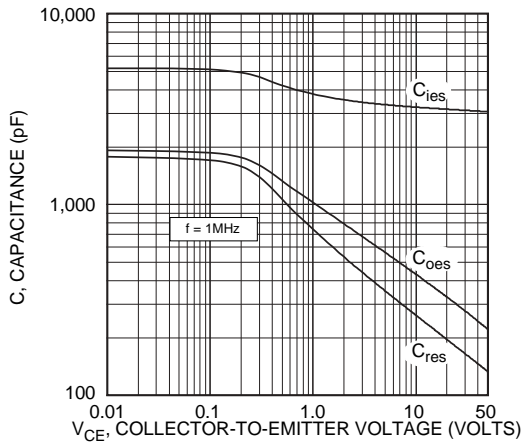


Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

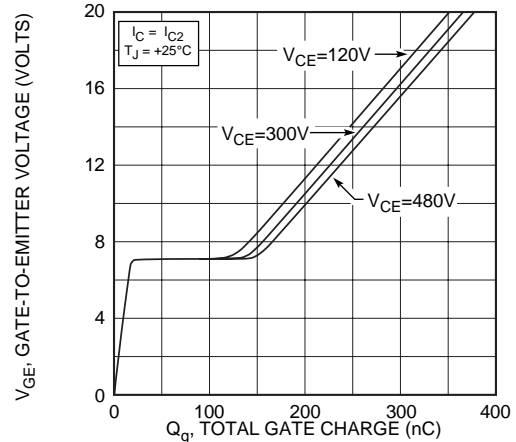


Figure 6, Gate Charges vs Gate-To-Emitter Voltage

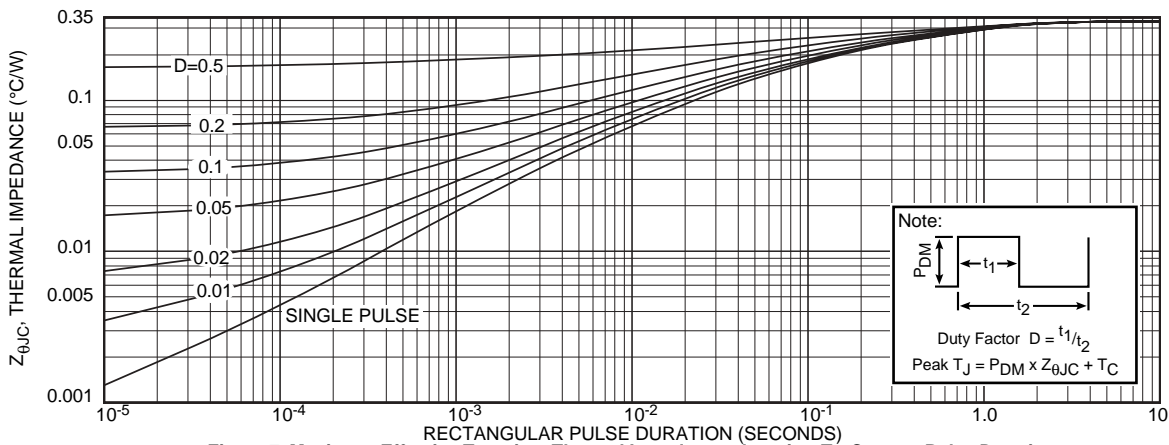


Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

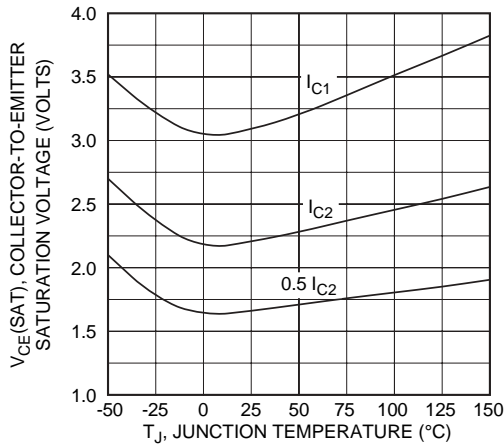


Figure 8, Typical  $V_{CE(SAT)}$  Voltage vs Junction Temperature

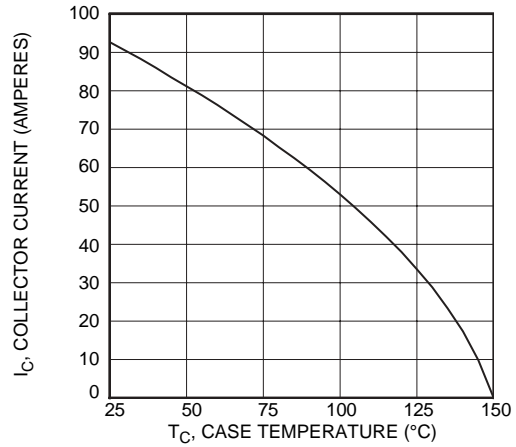


Figure 9, Maximum Collector Current vs Case Temperature

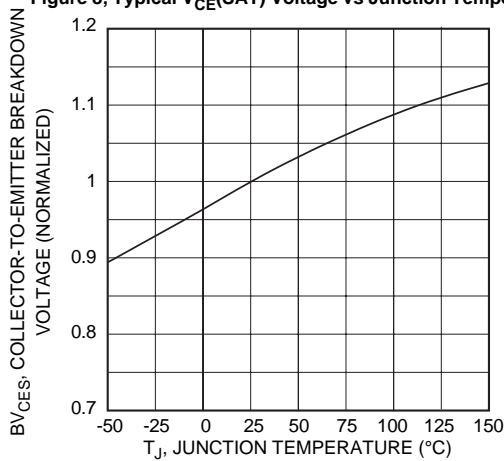


Figure 10, Breakdown Voltage vs Junction Temperature

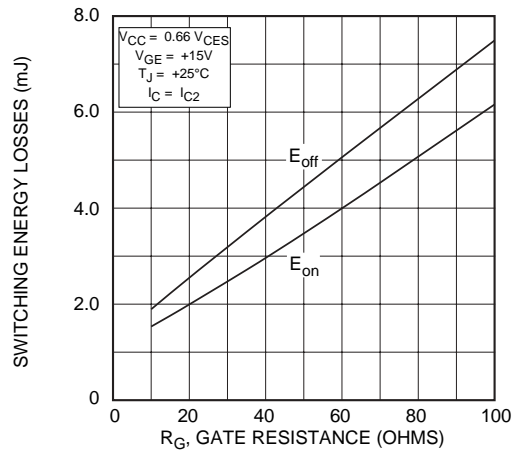


Figure 11, Typical Switching Energy Losses vs Gate Resistance

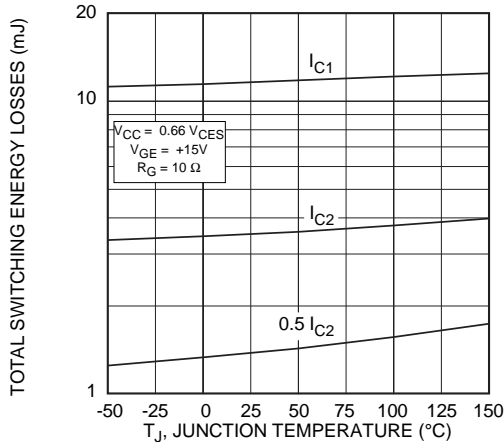


Figure 12, Typical Switching Energy Losses vs. Junction Temperature

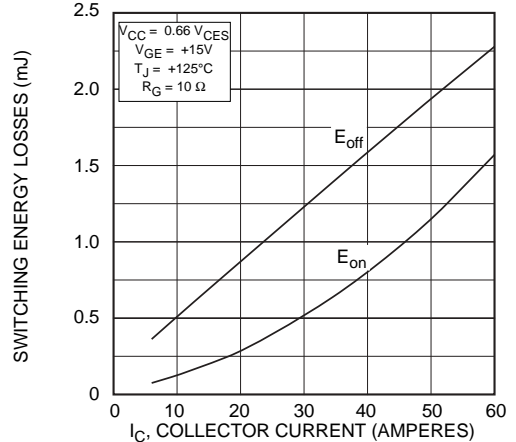


Figure 13, Typical Switching Energy Losses vs Collector Current

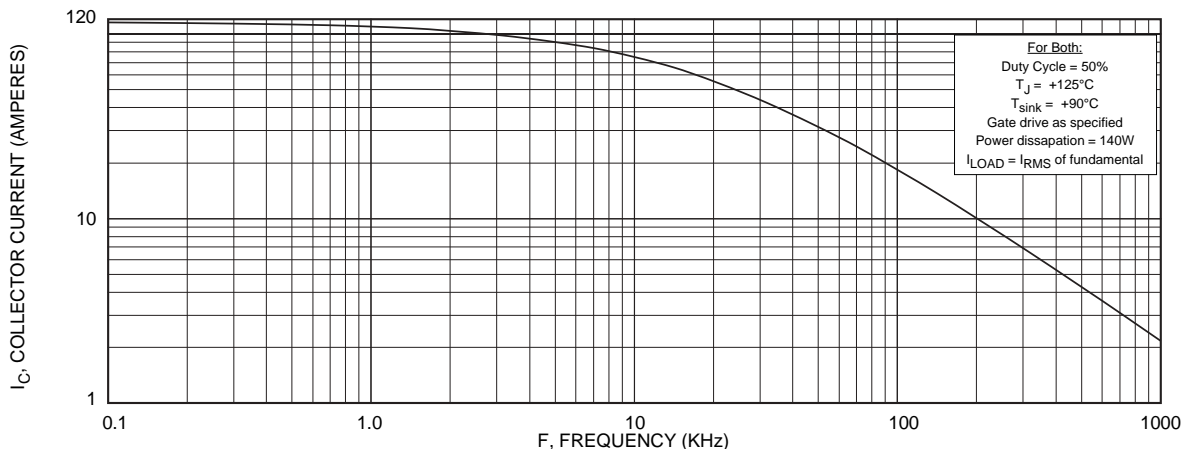


Figure 14, Typical Load Current vs Frequency

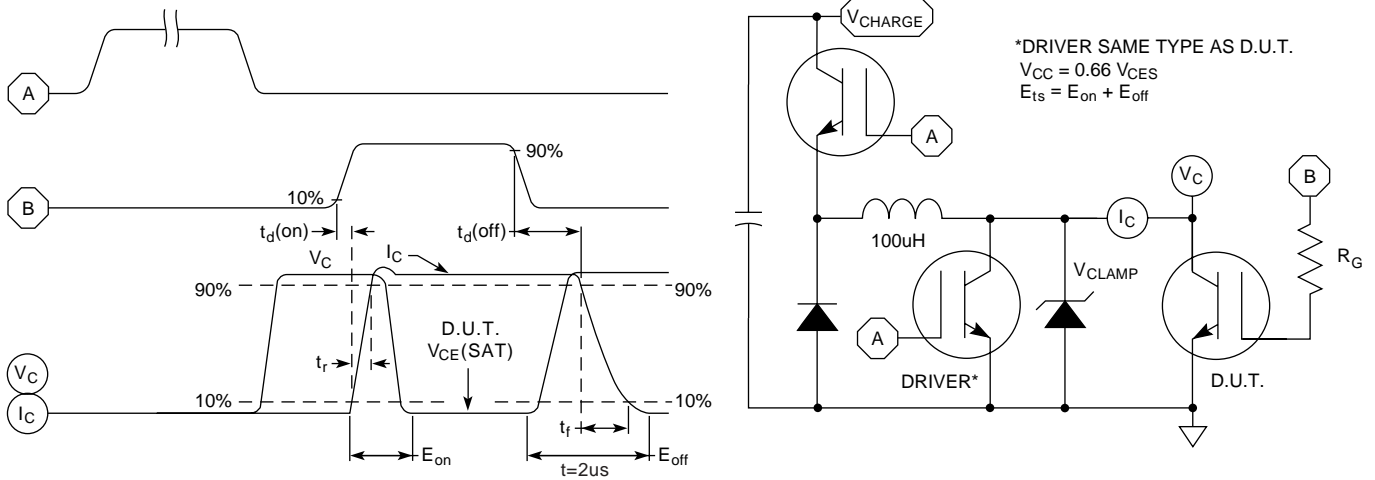


Figure 15, Switching Loss Test Circuit and Waveforms

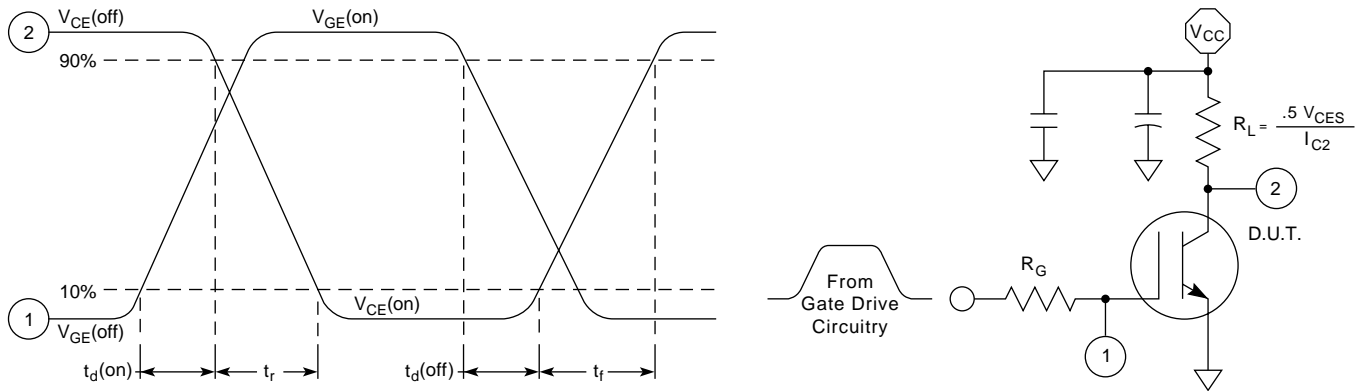
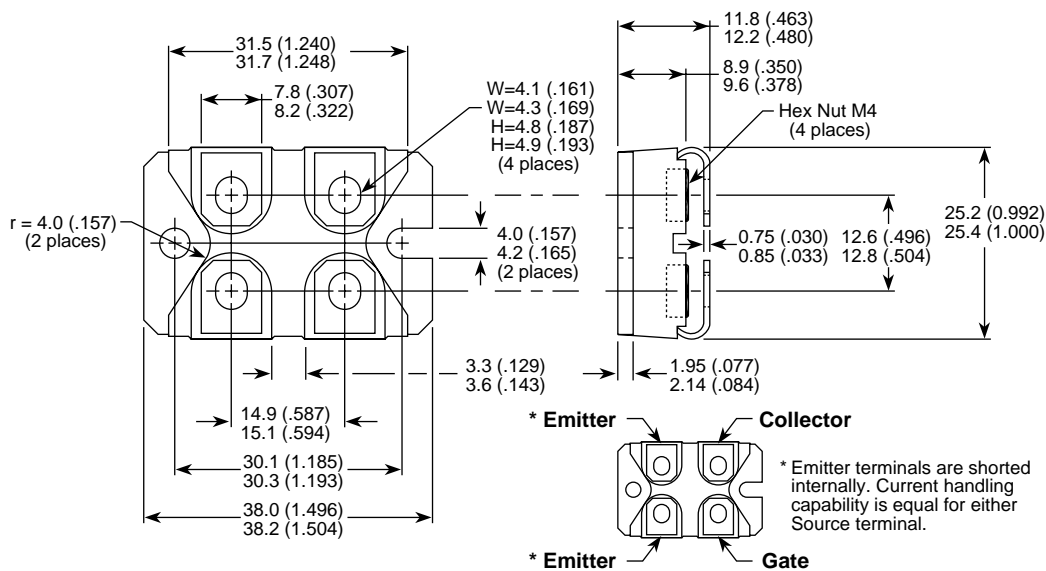


Figure 16, Resistive Switching Time Test Circuit and Waveforms

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches)

APT's devices are covered by one or more of the following U.S.patents:	4,895,810	5,045,903	5,089,434	5,182,234	5,019,522	5,262,336
	5,256,583	4,748,103	5,283,202	5,231,474	5,434,095	5,528,058