


## 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.

### Features

- Low Forward Voltage Drop
- Low Tail Current
- Integrated Gate Resistor
- Low EMI, High Reliability
- RoHS Compliant 
- RBSOA and SCSOA Rated
- High Frequency Switching to 50KHz
- Ultra Low Leakage Current




### Maximum Ratings

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

Symbol	Parameter	Ratings	Unit
$V_{CES}$	Collector-Emitter Voltage	600	Volts
$V_{GE}$	Gate-Emitter Voltage	$\pm 30$	
$I_{C1}$	Continuous Collector Current @ $T_C = 25^\circ C$	195	Amps
$I_{C2}$	Continuous Collector Current @ $T_C = 100^\circ C$	100	
$I_{CM}$	Pulsed Collector Current <sup>①</sup>	600	
SSOA	Switching Safe Operating Area @ $T_J = 150^\circ C$	600A @ 600V	
$P_D$	Total Power Dissipation	500	Watts
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to 150	$^\circ C$

### Static Electrical Characteristics

Symbol	Characteristic / Test Conditions	Min	Typ	Max	Unit
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage ( $V_{GE} = 0V, I_C = 5mA$ )	600	-	-	Volts
$V_{GE(TH)}$	Gate Threshold Voltage ( $V_{CE} = V_{GE}, I_C = 4.0mA, T_J = 25^\circ C$ )	3	4	5	
$V_{CE(ON)}$	Collector Emitter On Voltage ( $V_{GE} = 15V, I_C = 200A, T_J = 25^\circ C$ )	1.6	2.0	2.5	
	Collector Emitter On Voltage ( $V_{GE} = 15V, I_C = 200A, T_J = 125^\circ C$ )	-	2.5	-	
$I_{CES}$	Collector Cut-off Current ( $V_{CE} = 600V, V_{GE} = 0V, T_J = 25^\circ C$ ) <sup>②</sup>	-	-	25	$\mu A$
	Collector Cut-off Current ( $V_{CE} = 600V, V_{GE} = 0V, T_J = 125^\circ C$ ) <sup>②</sup>	-	-	1000	
$I_{GES}$	Gate-Emitter Leakage Current ( $V_{GE} = \pm 30V$ )	-	-	300	nA

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

**Dynamic Characteristic**
**APT200GT60JR**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{ies}$	Input Capacitance	$V_{GE} = 0V, V_{CE} = 25V$ $f = 1MHz$	-	8650	-	pF
$C_{oes}$	Output Capacitance		-	546	-	
$C_{res}$	Reverse Transfer Capacitance		-	1180	-	
$V_{GEP}$	Gate-to-Emitter Plateau Voltage	Gate Charge $V_{GE} = 15V$ $V_{CE} = 300V$ $I_C = 200A$	-	7.5	-	V
$Q_g$	Total Gate Charge <sup>③</sup>		-	946	-	nC
$Q_{ge}$	Gate-Emitter Charge		-	58	-	
$Q_{gc}$	Gate-Collector Charge		-	430	-	
SSOA	Switching Safe Operating Area	$T_J = 150^\circ C, R_G = 2.2\Omega, V_{GE} = 15V,$ $L = 100\mu H, V_{CE} = 600V$	600			A
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (25°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 200A$ $R_G = 2.2\Omega$ $T_J = +25^\circ C$	-	72	-	ns
$t_r$	Current Rise Time		-	160	-	
$t_{d(off)}$	Turn-Off Delay Time		-	952	-	
$t_f$	Current Fall Time		-	212	-	
$E_{on1}$	Turn-On Switching Energy <sup>④</sup>		-	-	-	
$E_{on2}$	Turn-On Switching Energy <sup>⑤</sup>	-	9193	-		
$E_{off}$	Turn-Off Switching Energy <sup>⑥</sup>	-	19290	-		
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (125°C) $V_{CC} = 400V$ $V_{GE} = 15V$ $I_C = 200A$ $R_G = 2.2\Omega$ $T_J = +125^\circ C$	-	71	-	ns
$t_r$	Current Rise Time		-	157	-	
$t_{d(off)}$	Turn-Off Delay Time		-	1030	-	
$t_f$	Current Fall Time		-	202	-	
$E_{on1}$	Turn-On Switching Energy <sup>④</sup>		-	-	-	$\mu J$
$E_{on2}$	Turn-On Switching Energy <sup>⑤</sup>		-	10460	-	
$E_{off}$	Turn-Off Switching Energy <sup>⑥</sup>		-	20210	-	

**Thermal and Mechanical Characteristics**

Symbol	Characteristic / Test Conditions	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction to Case (IGBT)	-	-	0.21	$^\circ C/W$
$R_{\theta JC}$	Junction to Case (DIODE)	-	-	N/A	
$W_T$	Package Weight	-	29.2	-	g
Torque	Terminals and Mounting Screws	-	-	10	in·lbf
		-	-	1.1	N·m
$V_{isolation}$	RMS Voltage (50-60Hz Sinusoidal Waveform from Terminals to Mounting Base for 1 Min.)	2500	-	-	Volts

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  $z$  a 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  $R_G$  is external gate resistance not including gate driver impedance.

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

# Typical Performance Curves

APT200GT60JR

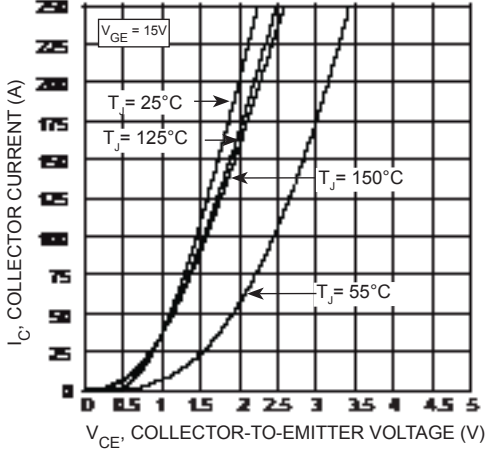


FIGURE 1, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

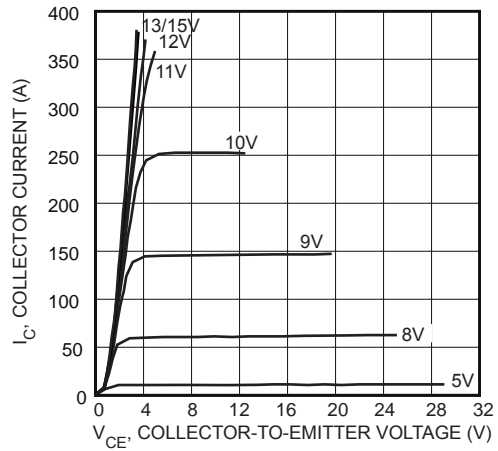


FIGURE 2, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

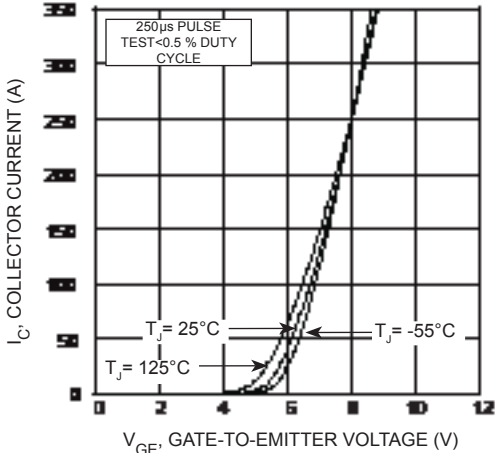


FIGURE 3, Transfer Characteristics

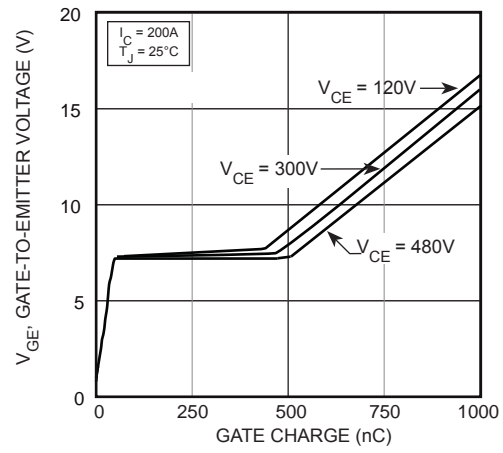


FIGURE 4, Gate charge

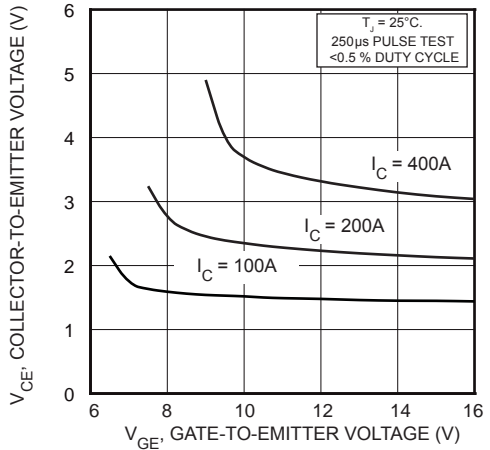


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

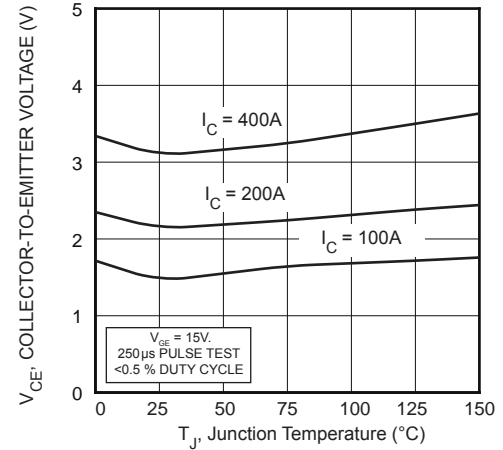


FIGURE 6, On State Voltage vs Junction Temperature

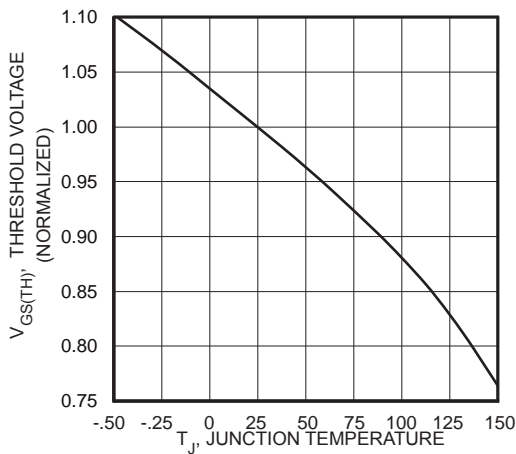


FIGURE 7, Threshold Voltage vs Junction Temperature

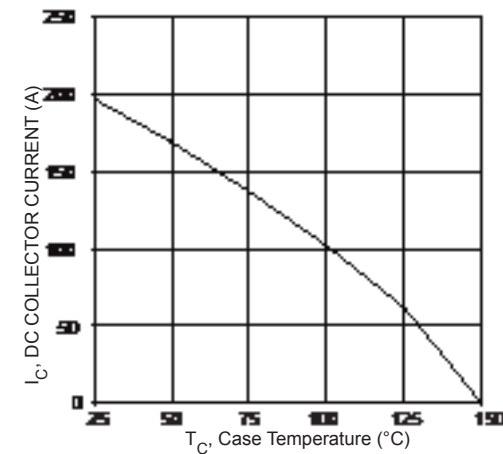


FIGURE 8, DC Collector Current vs Case Temperature

# Typical Performance Curves

APT200GT60JR

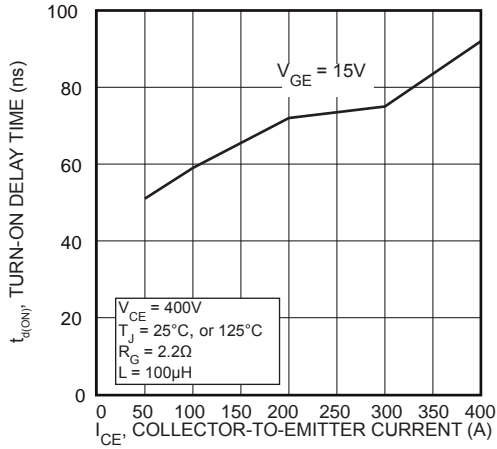


FIGURE 9, Turn-On Delay Time vs Collector Current

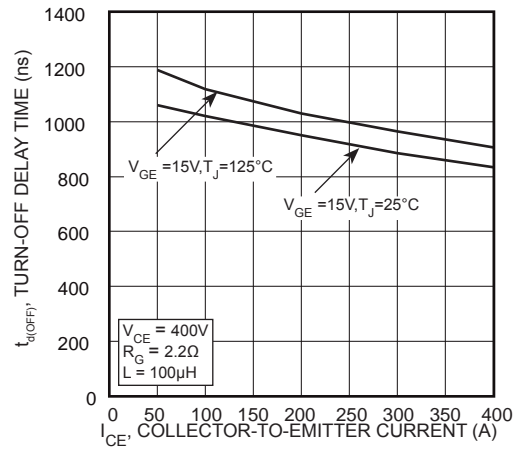


FIGURE 10, Turn-Off Delay Time vs Collector Current

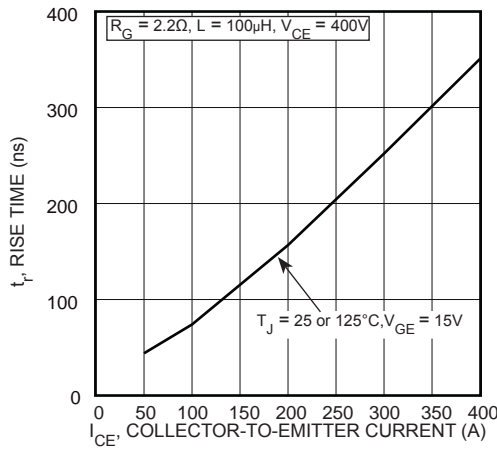


FIGURE 11, Current Rise Time vs Collector Current

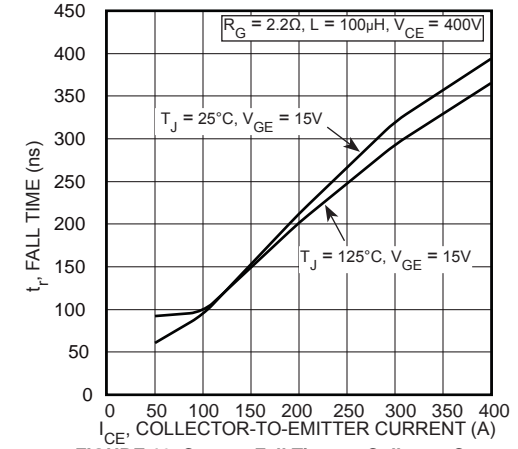


FIGURE 12, Current Fall Time vs Collector Current

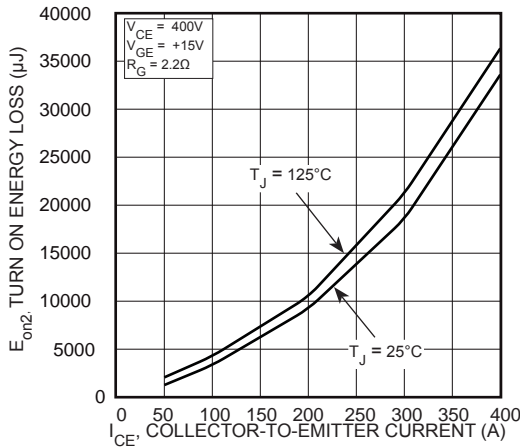


FIGURE 13, Turn-On Energy Loss vs Collector Current

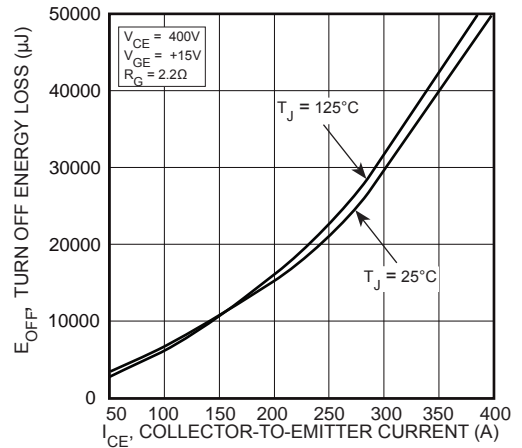


FIGURE 14, Turn-Off Energy Loss vs Collector Current

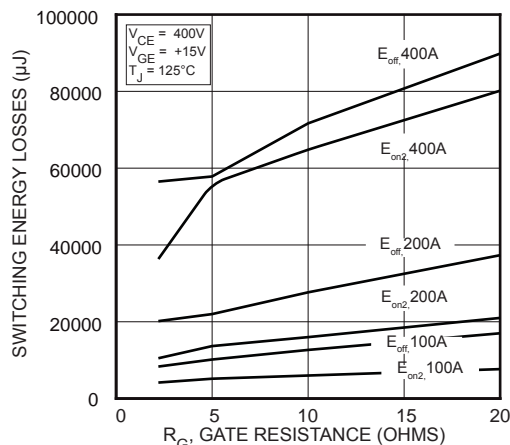


FIGURE 15, Switching Energy Losses vs Gate Resistance

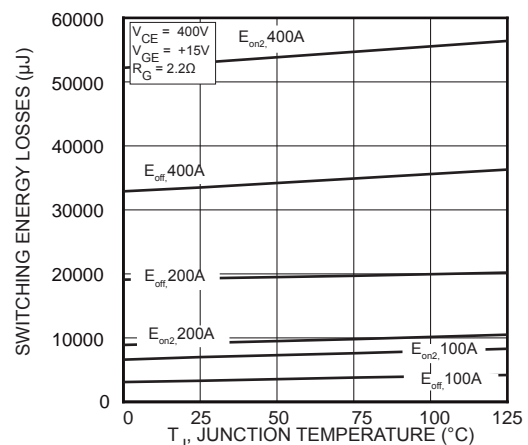


FIGURE 16, Switching Energy Losses vs Junction Temperature

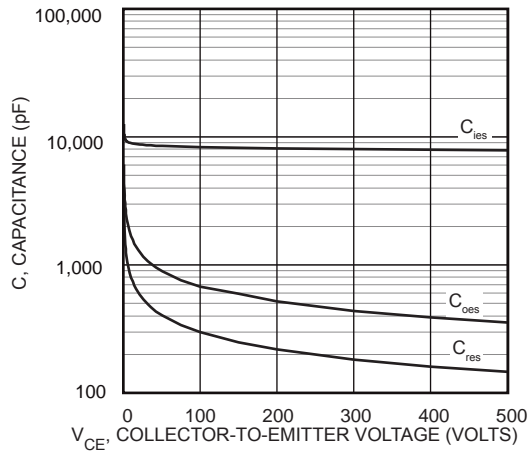


FIGURE 17, Capacitance vs Collector-To-Emitter Voltage

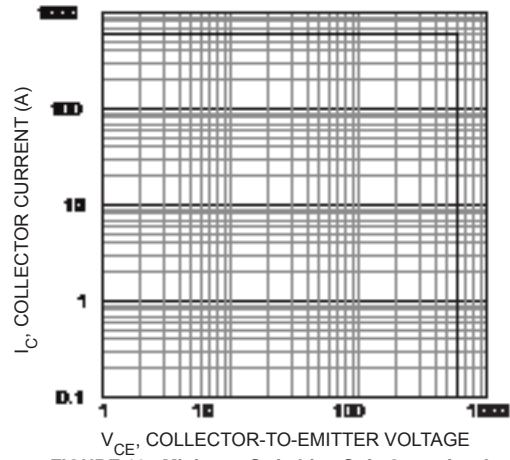


FIGURE 18, Minimum Switching Safe Operating Area

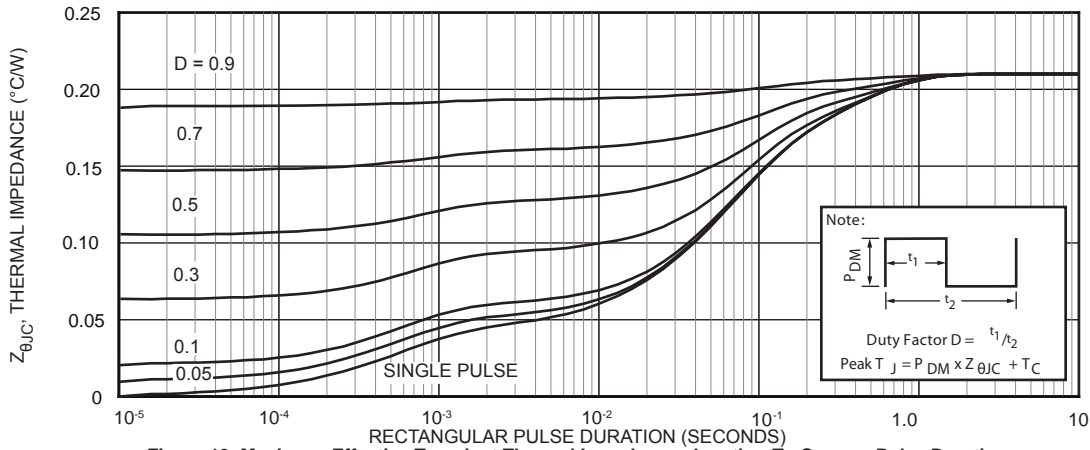


Figure 19, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

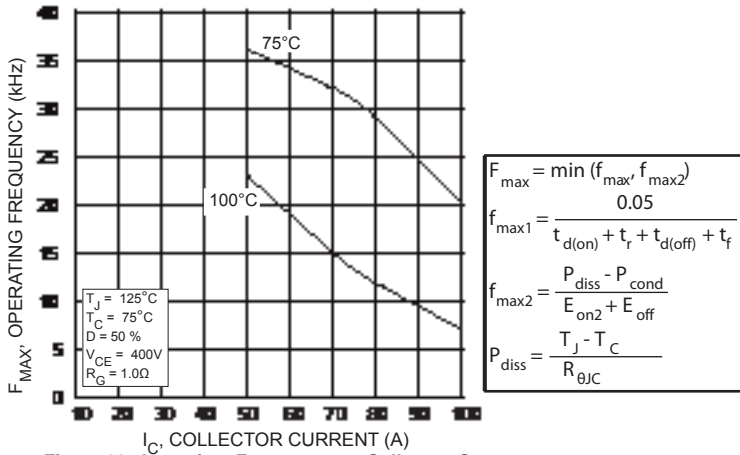


Figure 20, Operating Frequency vs Collector Current

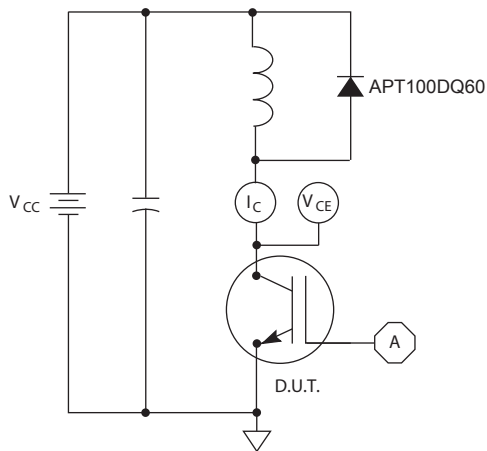


Figure 21, Inductive Switching Test Circuit

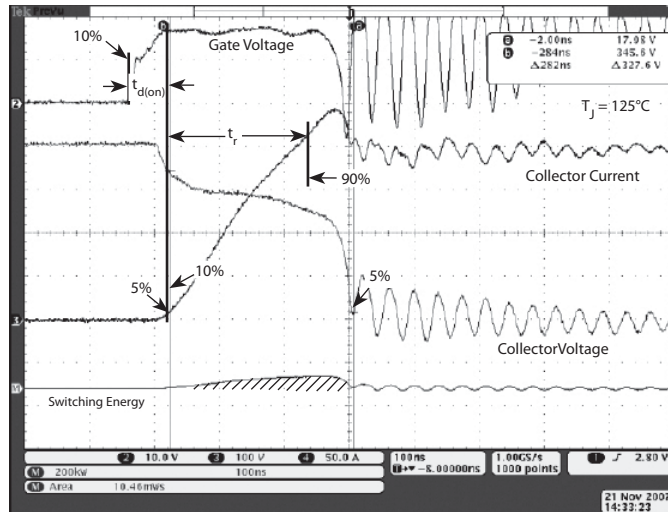


Figure 22, Turn-on Switching Waveforms and Definitions

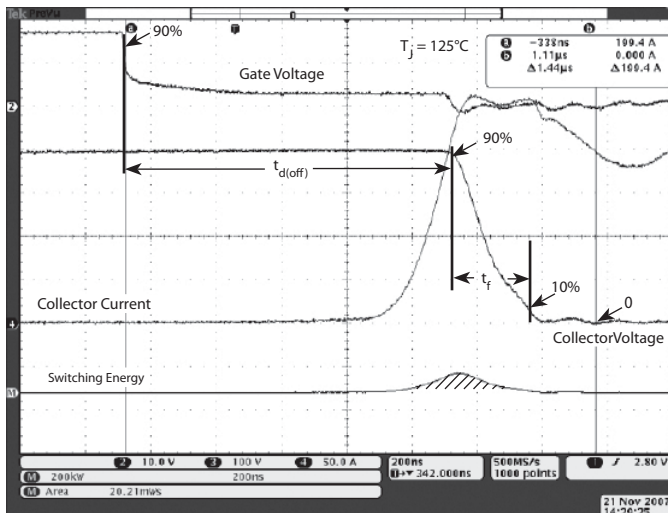
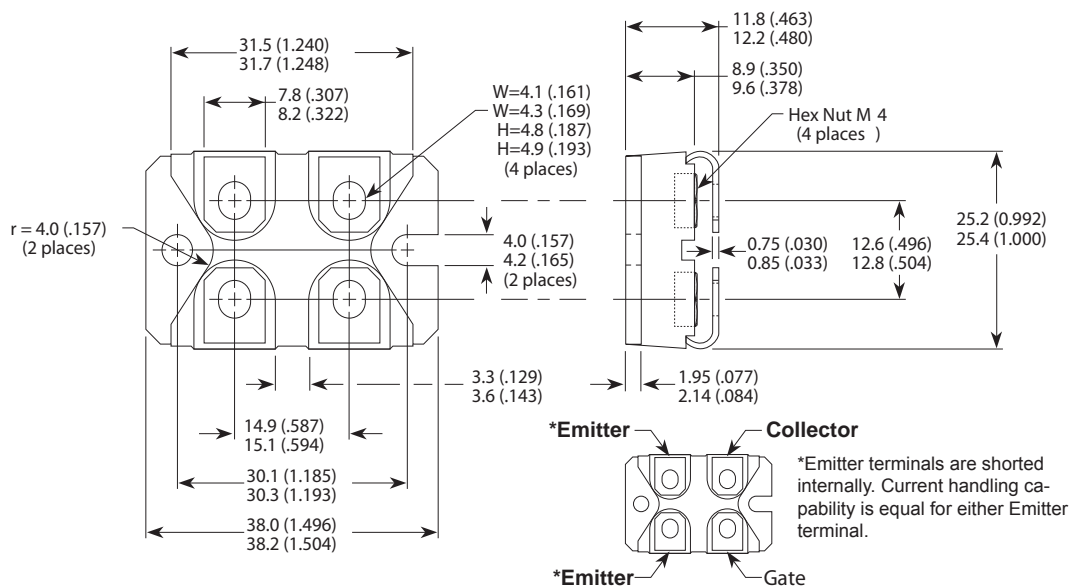


Figure 23, Turn-off Switching Waveforms and Definitions

SOT-227 (ISOTOP®) Package Outline



Dimensions in Millimeters and (Inches )

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