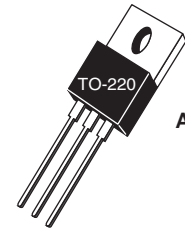



## High Speed PT IGBT

POWER MOS 8® is a high speed Punch-Through switch-mode IGBT. Low  $E_{off}$  is achieved through leading technology silicon design and lifetime control processes. A reduced  $E_{off} - V_{CE(ON)}$  tradeoff results in superior efficiency compared to other IGBT technologies. Low gate charge and a greatly reduced ratio of  $C_{res}/C_{ies}$  provide excellent noise immunity, short delay times and simple gate drive. The intrinsic chip gate resistance and capacitance of the poly-silicone gate structure help control di/dt during switching, resulting in low EMI, even when switching at high frequency.


**APT28GA60K**


Single die IGBT

### FEATURES

- Fast switching with low EMI
- Very Low  $E_{off}$  for maximum efficiency
- Ultra low  $C_{res}$  for improved noise immunity
- Low conduction loss
- Low gate charge
- Increased intrinsic gate resistance for low EMI
- RoHS compliant 

### TYPICAL APPLICATIONS

- ZVS phase shifted and other full bridge
- Half bridge
- High power PFC boost
- Welding
- UPS, solar, and other inverters
- High frequency, high efficiency industrial

### Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
$V_{CES}$	Collector Emitter Voltage	600	V
$I_{C1}$	Continuous Collector Current @ $T_c = 25^\circ\text{C}$	50	A
$I_{C2}$	Continuous Collector Current @ $T_c = 100^\circ\text{C}$	28	
$I_{CM}$	Pulsed Collector Current <sup>1</sup>	84	
$V_{GE}$	Gate-Emitter Voltage <sup>2</sup>	$\pm 30$	V
$P_D$	Total Power Dissipation @ $T_c = 25^\circ\text{C}$	223	W
SSOA	Switching Safe Operating Area @ $T_j = 150^\circ\text{C}$	84A @ 600V	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to 150	°C
$T_L$	Lead Temperature for Soldering: 0.063" from Case for 10 Seconds	300	

### Static Characteristics

 $T_J = 25^\circ\text{C}$  unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{BR(CES)}$	Collector-Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 1.0mA$	600			V
$V_{CE(on)}$	Collector-Emitter On Voltage	$V_{GE} = 15V, I_C = 16A$		2.0 1.9	2.5	
$V_{GE(th)}$	Gate Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 1mA$	3	4.5	6	µA
$I_{CES}$	Zero Gate Voltage Collector Current	$V_{CE} = 600V, V_{GE} = 0V$			250 2500	
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GS} = \pm 30V$			$\pm 100$	nA

### Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction to Case Thermal Resistance	-	-	0.56	°C/W
$W_T$	Package Weight	-	1.9	-	g
Torque	Mounting Torque (TO-220 Package), 4-40 or M3 screw			10	in-lbf

Dynamic Characteristics

T<sub>J</sub> = 25°C unless otherwise specified

APT28GA60K

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
C <sub>ies</sub>	Input Capacitance	Capacitance V <sub>GE</sub> = 0V, V <sub>CE</sub> = 25V f = 1MHz		2109		pF
C <sub>oes</sub>	Output Capacitance			214		
C <sub>res</sub>	Reverse Transfer Capacitance			26		
Q <sub>g</sub> <sup>3</sup>	Total Gate Charge	Gate Charge V <sub>GE</sub> = 15V V <sub>CE</sub> = 300V I <sub>C</sub> = 16A		90		nC
Q <sub>ge</sub>	Gate-Emitter Charge			14		
Q <sub>gc</sub>	Gate- Collector Charge			28		
SSOA	Switching Safe Operating Area	T <sub>J</sub> = 150°C, R <sub>G</sub> = 10Ω <sup>4</sup> , V <sub>GE</sub> = 15V, L = 100uH, V <sub>CE</sub> = 600V	84			A
t <sub>d(on)</sub>	Turn-On Delay Time	Inductive Switching (25°C) V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V I <sub>C</sub> = 16A R <sub>G</sub> = 10Ω <sup>4</sup> T <sub>J</sub> = +25°C		11		ns
t <sub>r</sub>	Current Rise Time			8		
t <sub>d(off)</sub>	Turn-Off Delay Time			101		
t <sub>f</sub>	Current Fall Time			27		
E <sub>on2</sub>	Turn-On Switching Energy			239		μJ
E <sub>off</sub> <sup>6</sup>	Turn-Off Switching Energy			170		
t <sub>d(on)</sub>	Turn-On Delay Time	Inductive Switching (125°C) V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V I <sub>C</sub> = 16A R <sub>G</sub> = 10Ω <sup>4</sup> T <sub>J</sub> = +125°C		11		ns
t <sub>r</sub>	Current Rise Time			10		
t <sub>d(off)</sub>	Turn-Off Delay Time			132		
t <sub>f</sub>	Current Fall Time			114		
E <sub>on2</sub>	Turn-On Switching Energy			412		μJ
E <sub>off</sub> <sup>6</sup>	Turn-Off Switching Energy			335		

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

2 Pulse test: Pulse Width < 380μs, duty cycle < 2%.

3 See Mil-Std-750 Method 3471.

4 R<sub>G</sub> is external gate resistance, not including internal gate resistance or gate driver impedance. (MIC4452)

5 E<sub>on2</sub> is the clamped inductive turn on energy that includes a commutating diode reverse recovery current in the IGBT turn on energy loss. A combi device is used for the clamping diode.

6 E<sub>off</sub> 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.

Typical Performance Curves

APT28GA60K

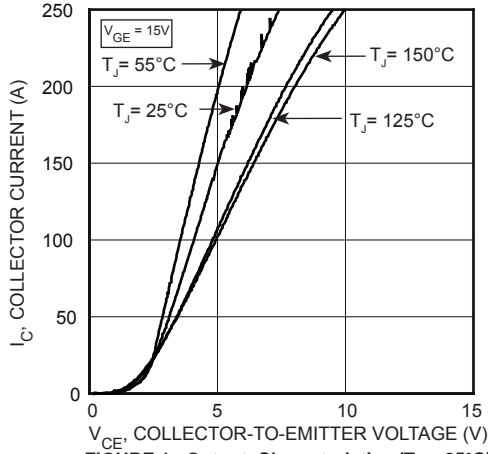


FIGURE 1, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

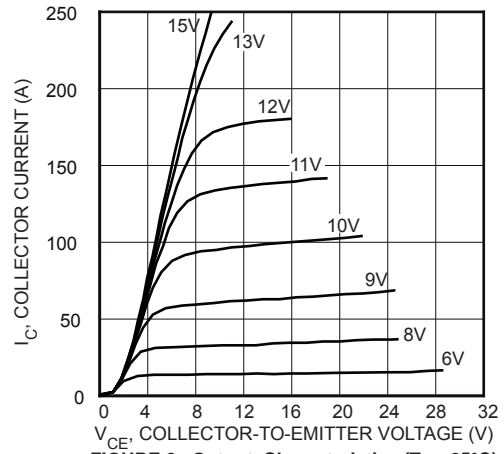


FIGURE 2, Output Characteristics ( $T_J = 25^\circ\text{C}$ )

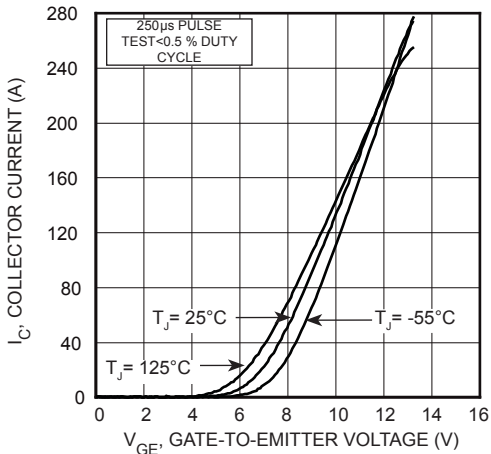


FIGURE 3, Transfer Characteristics

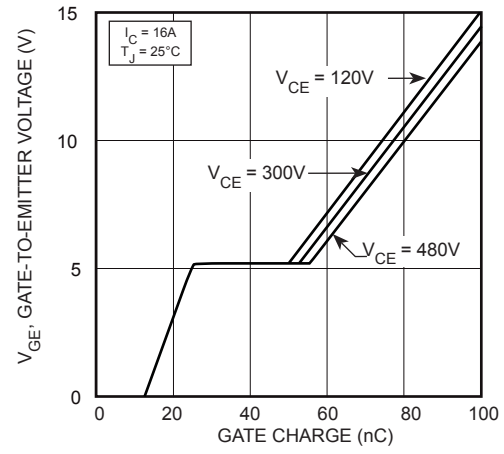


FIGURE 4, Gate charge

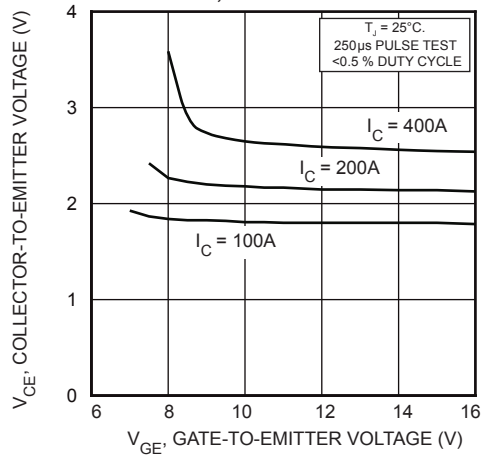


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

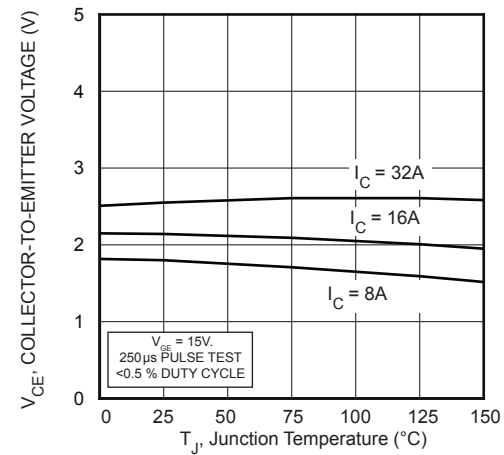


FIGURE 6, On State Voltage vs Junction Temperature

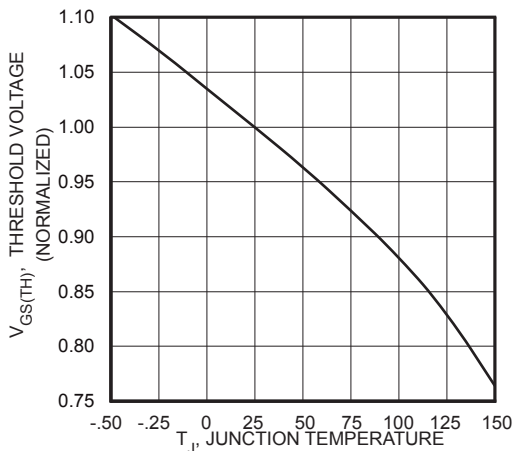


FIGURE 7, Threshold Voltage vs Junction Temperature

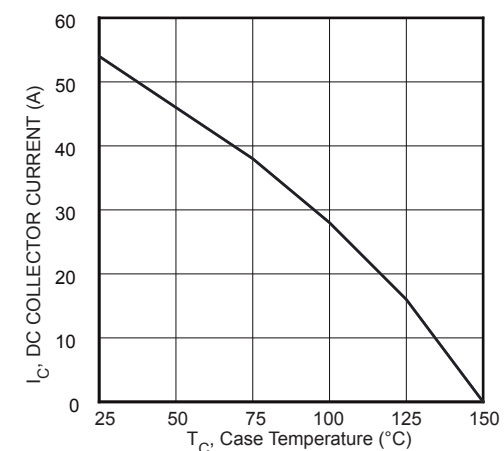


FIGURE 8, DC Collector Current vs Case Temperature

# Typical Performance Curves

APT28GA60K

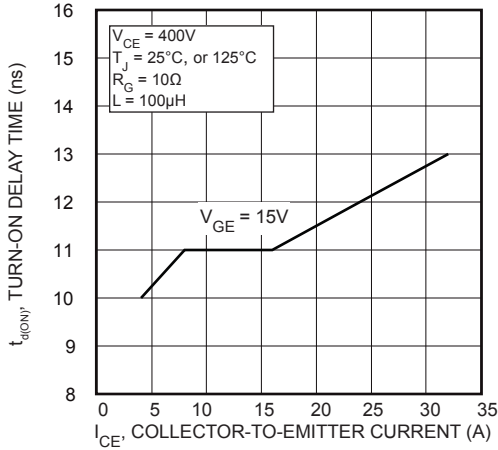


FIGURE 9, Turn-On Delay Time vs Collector Current

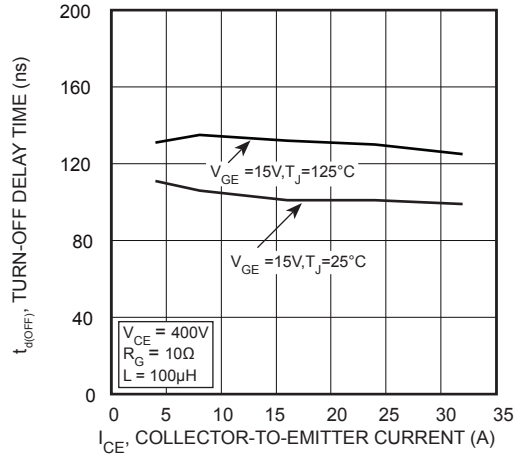


FIGURE 10, Turn-Off Delay Time vs Collector Current

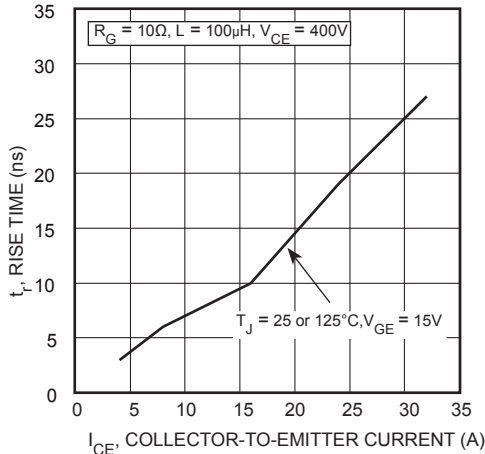


FIGURE 11, Current Rise Time vs Collector Current

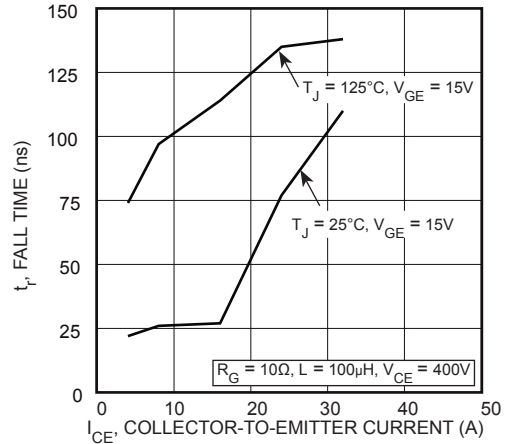


FIGURE 12, Current Fall Time vs Collector Current

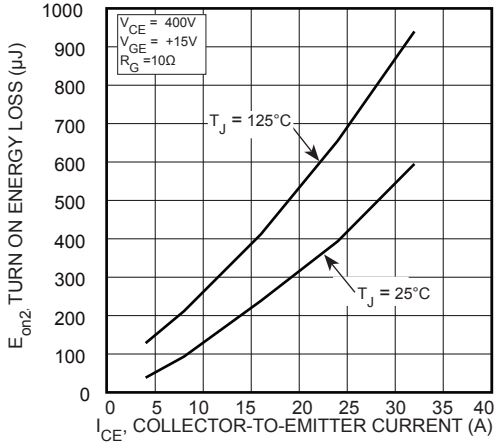


FIGURE 13, Turn-On Energy Loss vs Collector Current

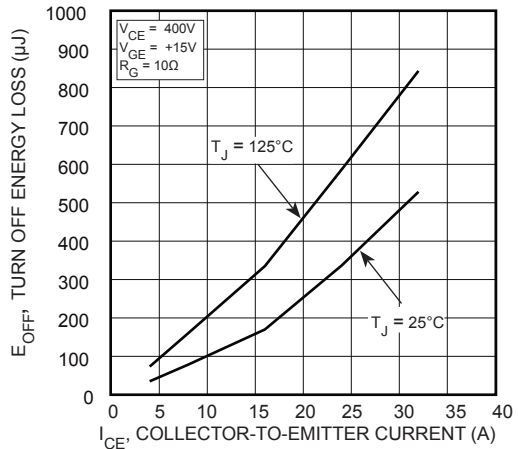


FIGURE 14, Turn-Off Energy Loss vs Collector Current

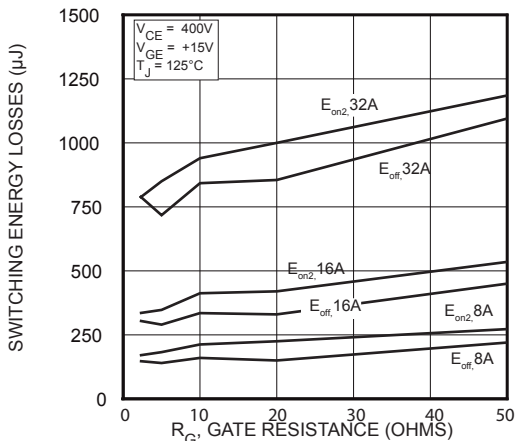


FIGURE 15, Switching Energy Losses vs Gate Resistance

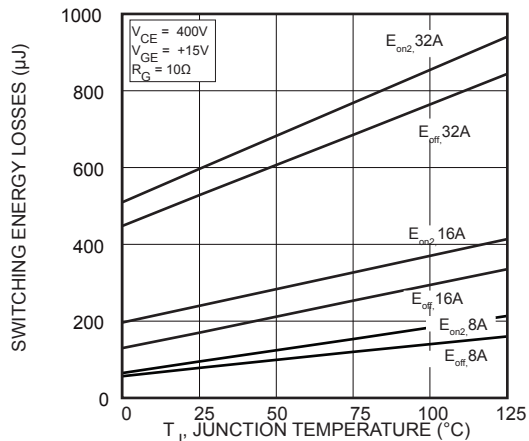


FIGURE 16, Switching Energy Losses vs Junction Temperature

# Typical Performance Curves

APT28GA60K

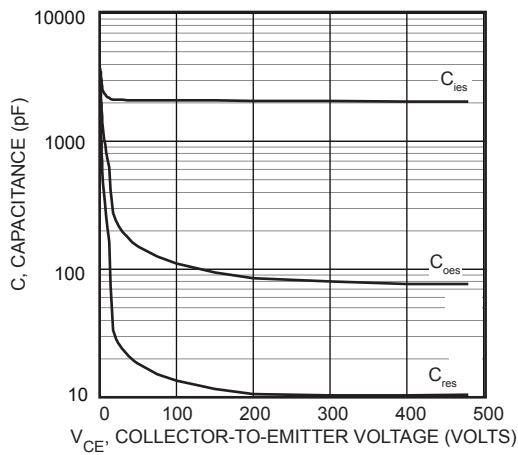


FIGURE 17, Capacitance vs Collector-To-Emitter Voltage

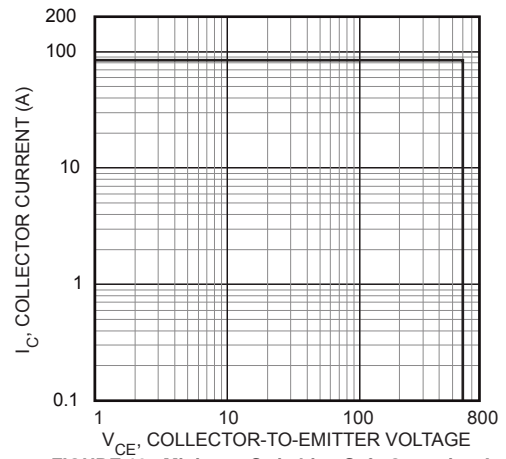


FIGURE 18, Minimum Switching Safe Operating Area

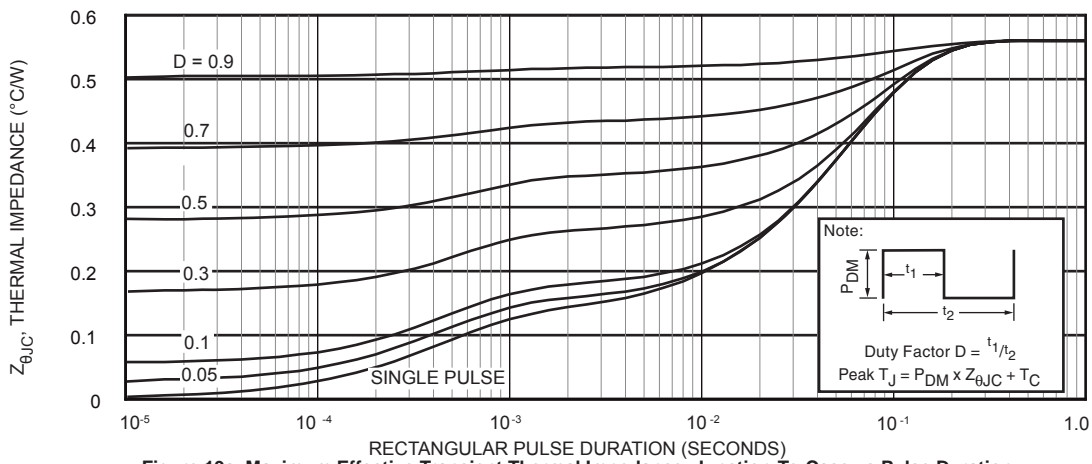


Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

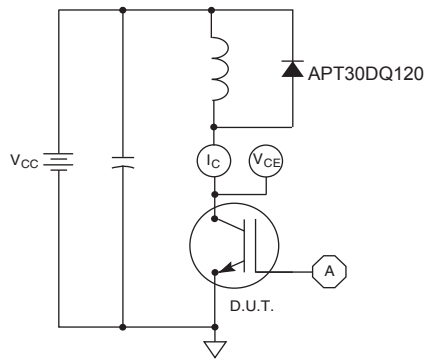


Figure 12, Inductive Switching Test Circuit

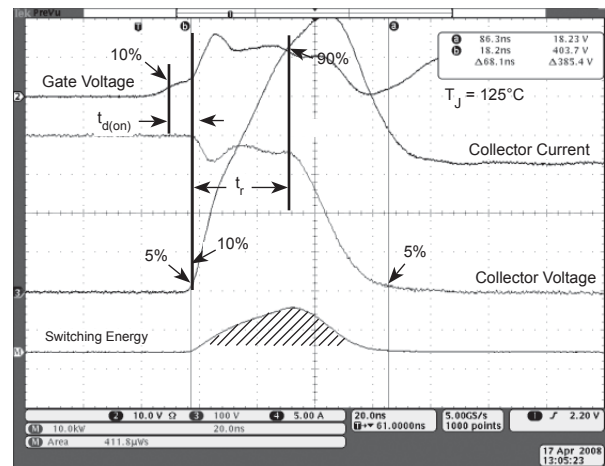


Figure 13, Turn-on Switching Waveforms and Definitions

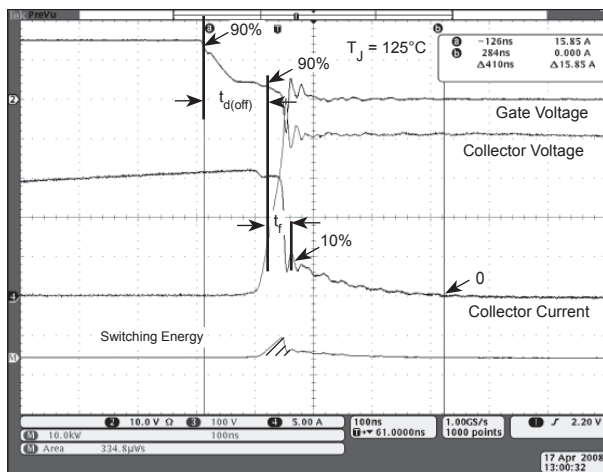
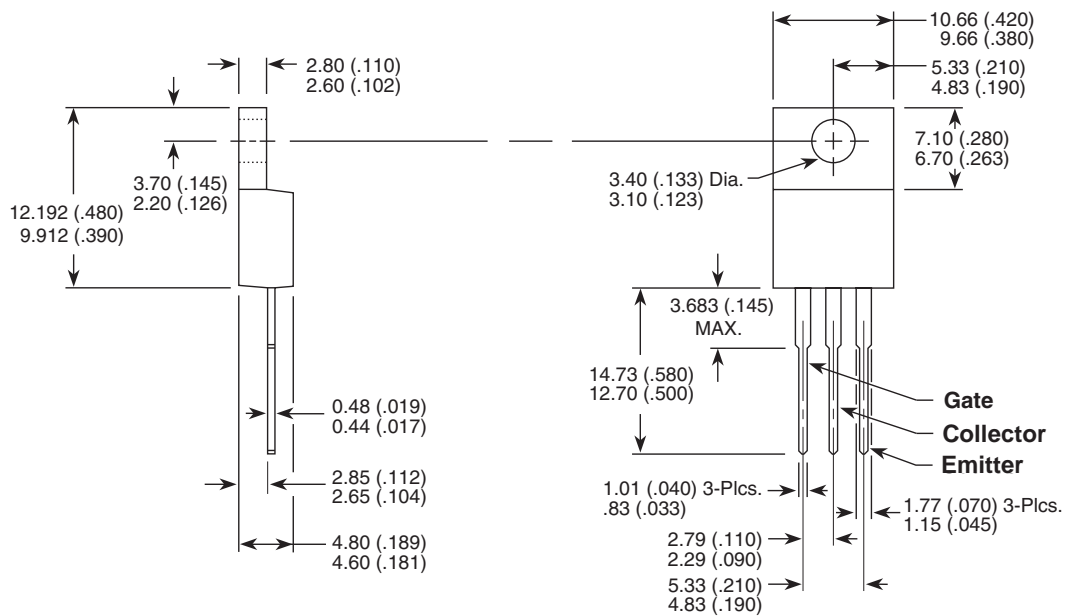


Figure 14, Turn-off Switching Waveforms and Definitions

TO-220 (K) Package Outline



Dimensions in Millimeters and (Inches)

Microsemi's products are covered by one or more of U.S. patents 4,895,810 5,045,903 5,089,434 5,182,234 5,019,522 5,262,336 6,503,786 5,256,583 4,748,103 5,283,202 5,231,474 5,434,095 5,528,058 6,939,743, 7,352,045 5,283,201 5,801,417 5,648,283 7,196,634 6,664,594 7,157,886 6,939,743 7,342,262 and foreign patents. US and Foreign patents pending. All Rights Reserved.