



ON Semiconductor®

# FGB20N60SFD-F085

## 600V, 20A Field Stop IGBT

### Features

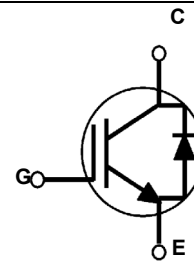
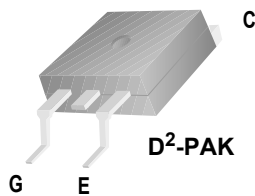
- High current capability
- Low saturation voltage:  $V_{CE(sat)} = 2.2V @ I_C = 20A$
- High input impedance
- Fast switching
- Qualified to Automotive Requirements of AEC-Q101
- RoHS compliant

### Applications

- Inverters, SMPS, PFC, UPS
- Automotive Chargers, Converters, High Voltage Auxiliaries

### General Description

Using novel field-stop IGBT technology, ON Semiconductor's new series of field-stop IGBTs offers the optimum performance for automotive chargers, inverters, and other applications where low conduction and switching losses are essential.



### Absolute Maximum Ratings

Symbol	Description	Ratings	Units
$V_{CES}$	Collector to Emitter Voltage	600	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C = 25^\circ C$	40	A
	Collector Current @ $T_C = 100^\circ C$	20	A
$I_{CM(1)}$	Pulsed Collector Current @ $T_C = 25^\circ C$	60	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ C$	20	A
	Diode Forward Current @ $T_C = 100^\circ C$	10	A
$I_{FM(1)}$	Pulsed Diode Maximum Forward Current	60	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ C$	208	W
	Maximum Power Dissipation @ $T_C = 100^\circ C$	83	W
$T_J$	Operating Junction Temperature	-55 to +150	$^\circ C$
$T_{stg}$	Storage Temperature Range	-55 to +150	$^\circ C$
$T_L$	Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds	300	$^\circ C$

### Thermal Characteristics

Symbol	Parameter	Ratings	Units
$R_{\theta JC}(IGBT)(2)$	Thermal Resistance, Junction to Case	0.6	$^\circ C/W$
$R_{\theta JC}(Diode)$	Thermal Resistance, Junction to Case	2.6	$^\circ C/W$

Symbol	Parameter	Typ.	Units
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (PCB Mount)(2)	75	$^\circ C/W$

FGB20N60SFD-F085 600V, 20A Field Stop IGBT

## Package Marking and Ordering Information

Device Marking	Device	Package	Packaging Type	Qty per Tube	Max Qty per Box
FGB20N60SFD	FGB20N60SFD-F085	TO-263	Tube	50ea	-

## Electrical Characteristics of the IGBT T<sub>C</sub> = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>Off Characteristics</b>						
$V_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	600	-	-	V
$\frac{\Delta V_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	-	0.79	-	V/°C
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0V$	-	-	250	$\mu A$
		ICES at 80%*BV <sub>CES</sub> , 150°C	-	-	250	
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0V$	-	-	±400	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250\mu A, V_{CE} = V_{GE}$	4.0	4.8	6.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 20A, V_{GE} = 15V$	-	2.2	2.85	V
		$I_C = 20A, V_{GE} = 15V, T_C = 125^\circ C$	-	2.4	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	-	940	1250	pF
$C_{oes}$	Output Capacitance		-	110	146	pF
$C_{res}$	Reverse Transfer Capacitance		-	40	53	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 20A, R_G = 10\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^\circ C$	-	10	13	ns
$t_r$	Rise Time		-	16	21	ns
$t_{d(off)}$	Turn-Off Delay Time		-	90	120	ns
$t_f$	Fall Time		-	24	36	ns
$E_{on}$	Turn-On Switching Loss		-	0.31	0.41	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.13	0.21	mJ
$E_{ts}$	Total Switching Loss	-	0.44	0.59	mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 20A, R_G = 10\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 125^\circ C$	-	12	16	ns
$t_r$	Rise Time		-	16	21	ns
$t_{d(off)}$	Turn-Off Delay Time		-	95	126	ns
$t_f$	Fall Time		-	28	43	ns
$E_{on}$	Turn-On Switching Loss		-	0.45	0.60	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.21	0.38	mJ
$E_{ts}$	Total Switching Loss	-	0.66	0.88	mJ	
$Q_g$	Total Gate Charge	$V_{CE} = 400V, I_C = 20A, V_{GE} = 15V$	-	63	95	nC
$Q_{ge}$	Gate to Emitter Charge		-	7	11	nC
$Q_{gc}$	Gate to Collector Charge		-	32	48	nC

**Electrical Characteristics of the Diode**  $T_C = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 10A$	$T_C = 25^\circ\text{C}$	-	1.9	2.5	V
			$T_C = 125^\circ\text{C}$	-	1.7	-	
$t_{rr}$	Diode Reverse Recovery Time	$I_{ES} = 10A, dI_{ES}/dt = 200A/\mu\text{s}$	$T_C = 25^\circ\text{C}$	-	111	-	ns
			$T_C = 125^\circ\text{C}$	-	204	-	
$Q_{rr}$	Diode Reverse Recovery Charge	$I_{ES} = 10A, dI_{ES}/dt = 200A/\mu\text{s}$	$T_C = 25^\circ\text{C}$	-	174	244	nC
			$T_C = 125^\circ\text{C}$	-	463	-	

**Notes:**

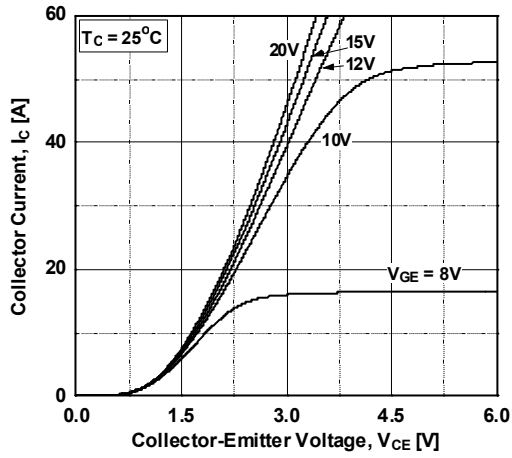
1: Repetitive rating: Pulse width limited by max. junction temperature

2:  $R_{thjc}$  for D2-PAK: according to Mil standard 883-1012 test method.

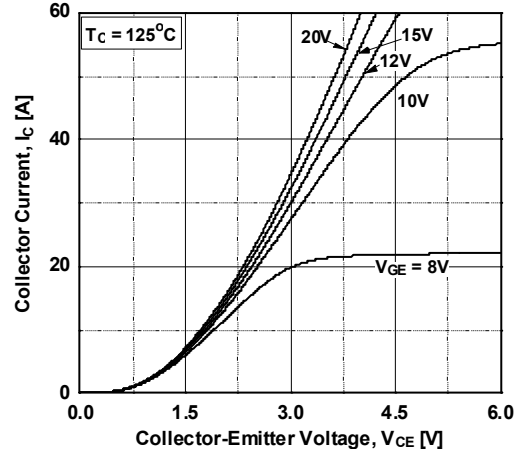
$R_{thja}$  for D2-PAK: according to JESD51-2, test method environmental condition and JESD51-3, low effective thermal conductivity test board for leaded surface mount package. thermal measurements. JESD51-2: Integrated Circuits Thermal Test Method Environmental Conditions - Natural Convection (Still Air).

## Typical Performance Characteristics

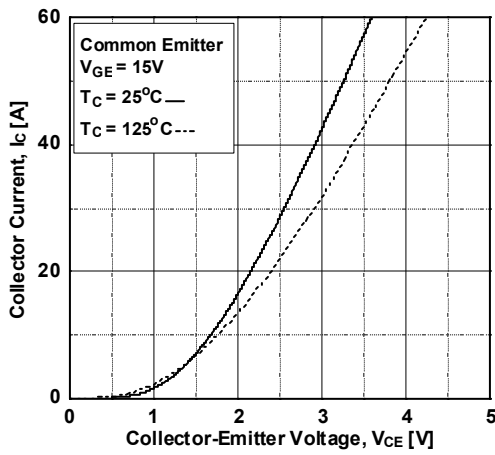
**Figure 1. Typical Output Characteristics**



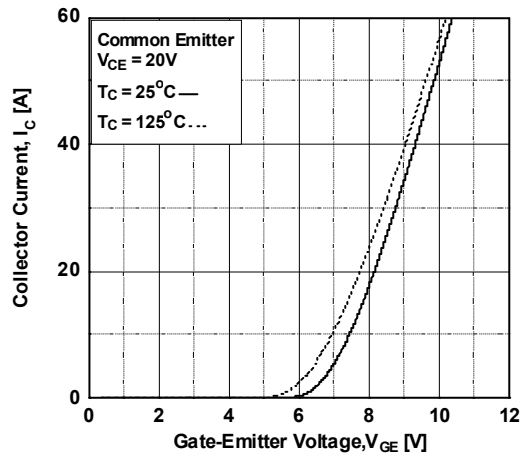
**Figure 2. Typical Output Characteristics**



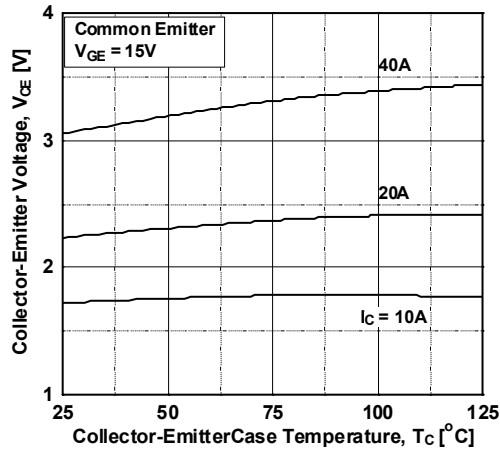
**Figure 3. Typical Saturation Voltage Characteristics**



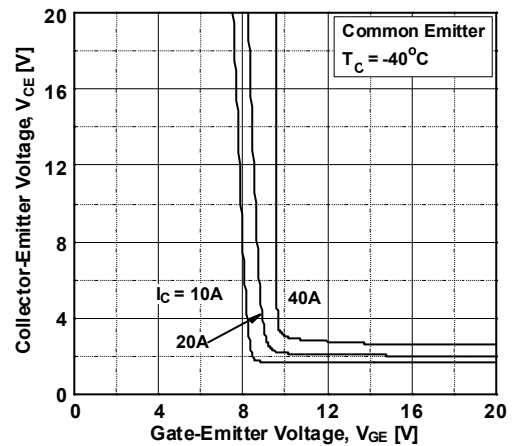
**Figure 4. Transfer Characteristics**



**Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level**



**Figure 6. Saturation Voltage vs. Vge**



## Typical Performance Characteristics

Figure 7. Saturation Voltage vs.  $V_{GE}$

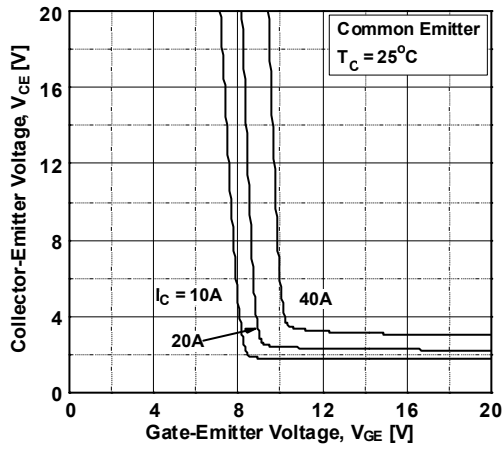


Figure 8. Saturation Voltage vs.  $V_{GE}$

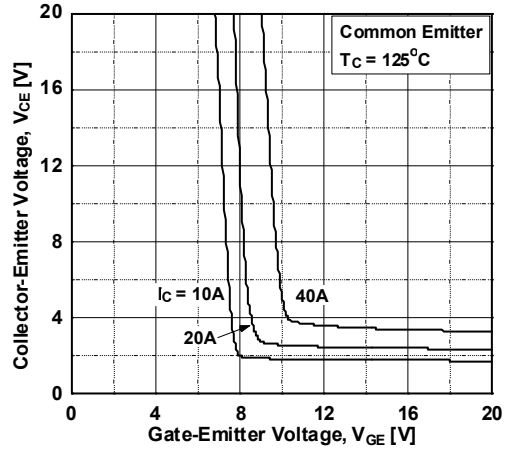


Figure 9. Capacitance Characteristics

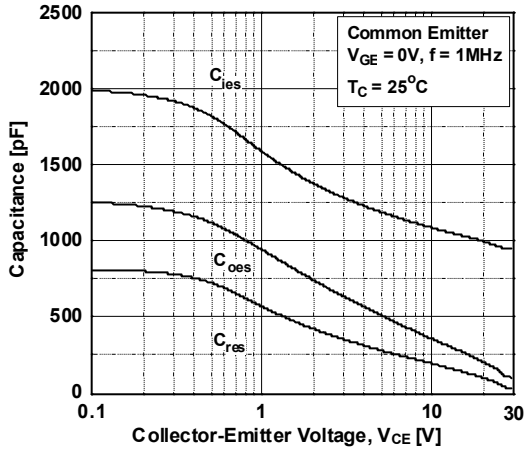


Figure 10. Gate charge Characteristics

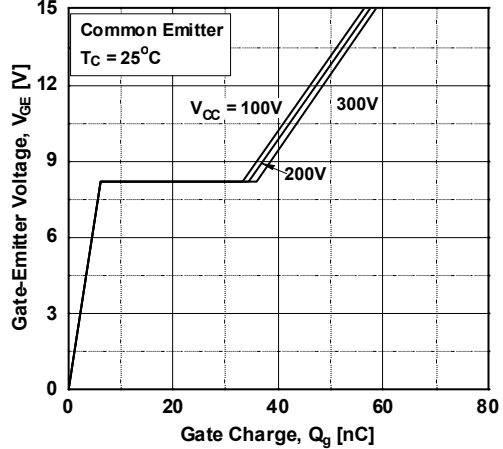


Figure 11. SOA Characteristics

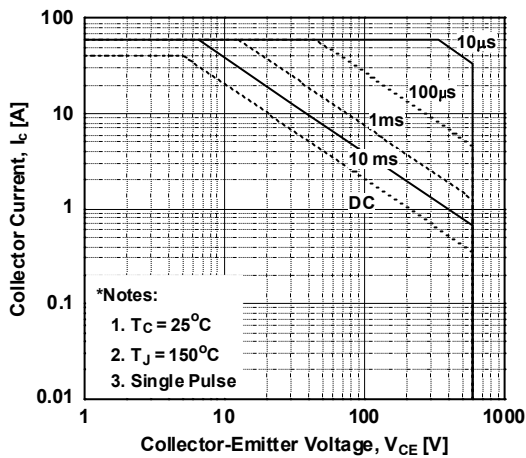
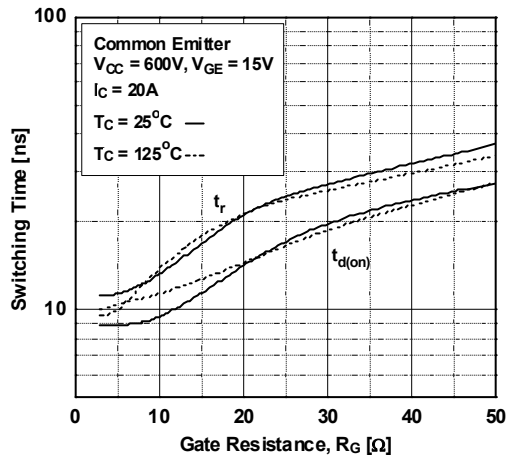
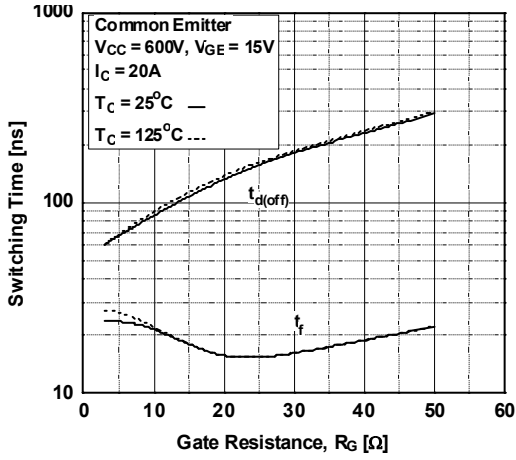


Figure 12. Turn-on Characteristics vs. Gate Resistance

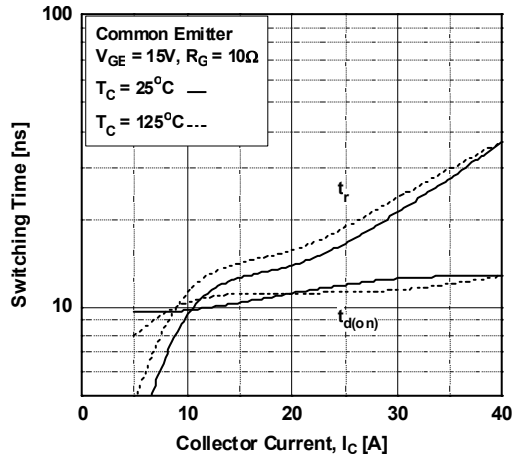


## Typical Performance Characteristics

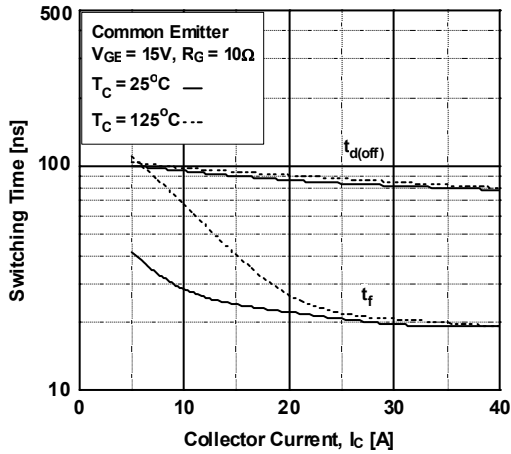
**Figure 13. Turn-off Characteristics vs. Gate Resistance**



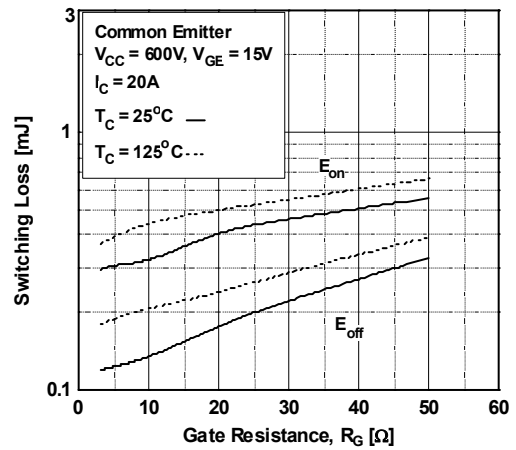
**Figure 14. Turn-on Characteristics vs. Collector Current**



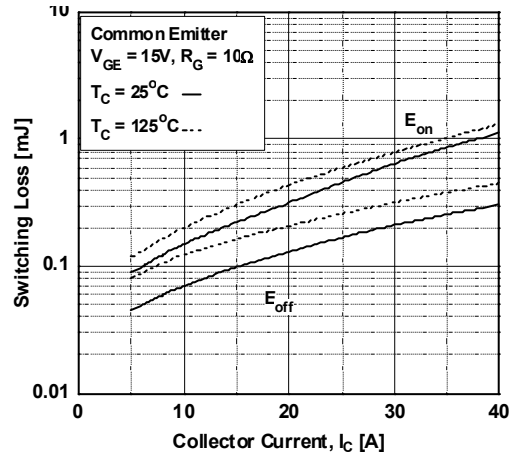
**Figure 15. Turn-off Characteristics vs. Collector Current**



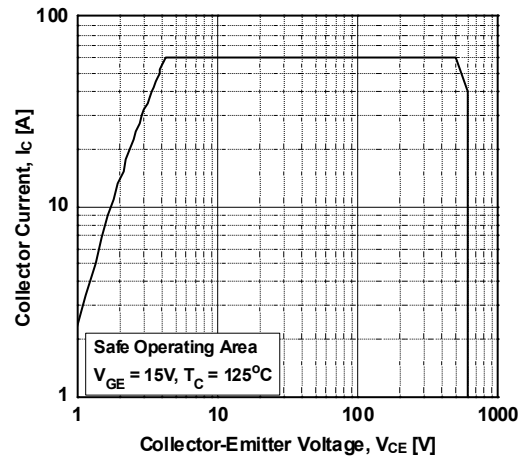
**Figure 16. Switching Loss vs. Gate Resistance**



**Figure 17. Switching Loss vs. Collector Current**



**Figure 18. Turn off Switching SOA Characteristics**



## Typical Performance Characteristics

Figure 19. Forward Characteristics

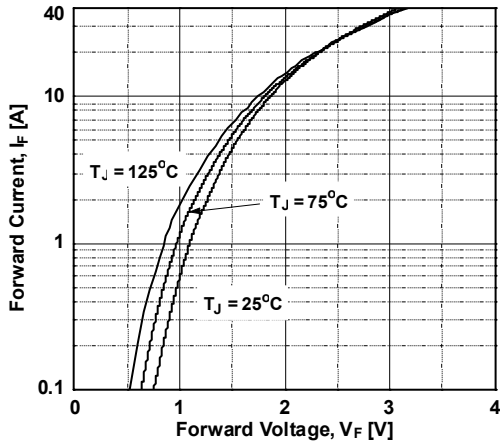


Figure 20. Typical Reverse Current vs. Reverse Voltage

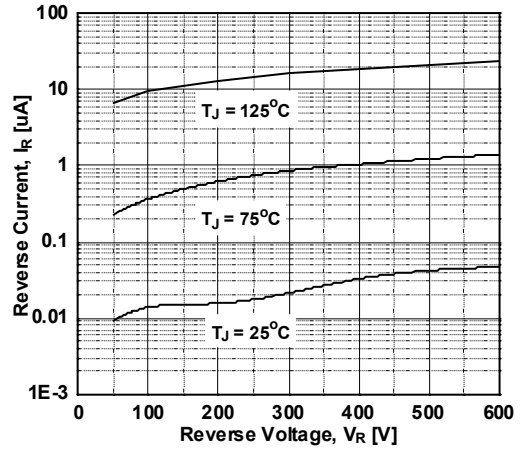


Figure 21. Stored Charge

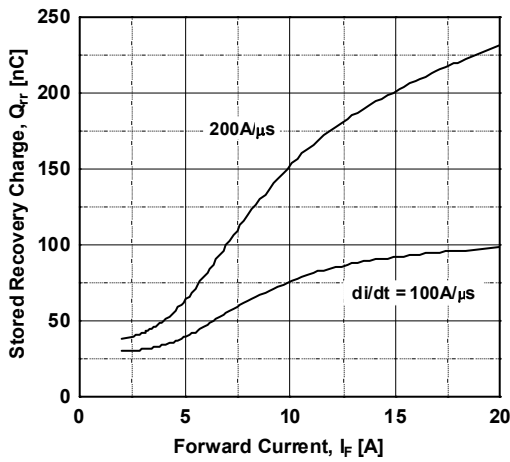


Figure 22. Reverse Recovery Time

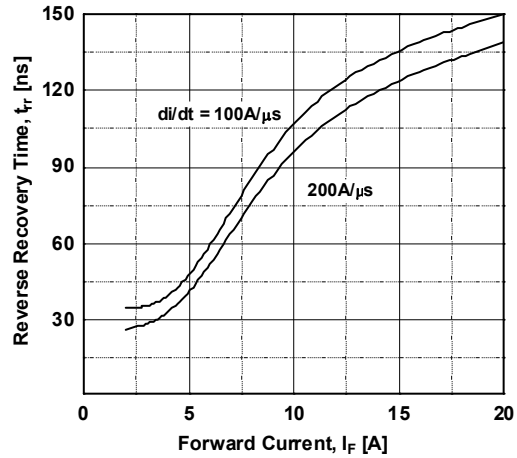
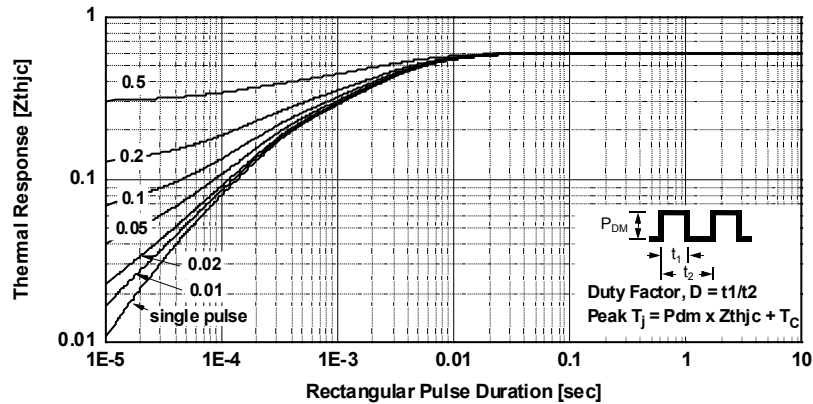
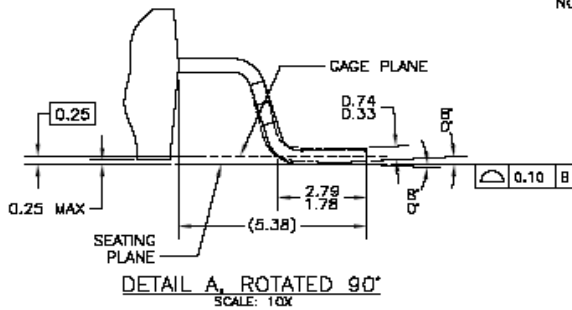
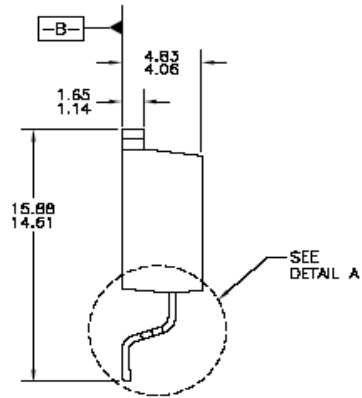
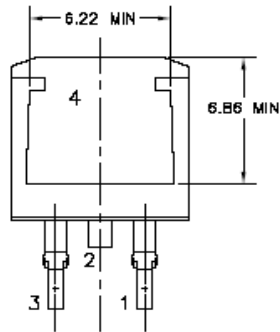
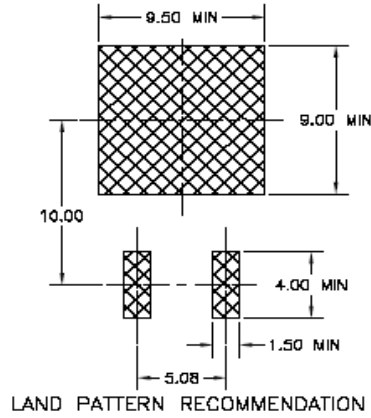
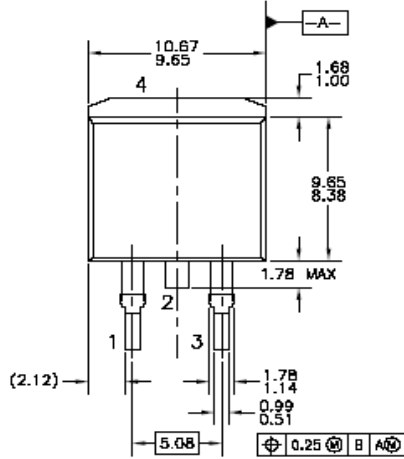


Figure 23. Transient Thermal Impedance of IGBT



**Mechanical Dimensions**

**D<sup>2</sup>PAK**



- NOTES: UNLESS OTHERWISE SPECIFIED
- A) ALL DIMENSIONS ARE IN MILLIMETERS.
  - B) REFERENCE JEDEC, TO-263, ISSUE D, VARIATION AB, DATED JULY 2003.
  - C) DIMENSIONING AND TOLERANCING PER ANSI Y14.5M - 1982.
  - D) LOCATION OF THE PIN HOLE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE).
  - E) PRESENCE OF TRIMMED CENTER LEAD IS OPTIONAL.

T02B3AD2REV D

Dimensions in Millimeters



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