



April 2014

# FGA40N65SMD

## 650 V, 40 A Field Stop IGBT

### Features

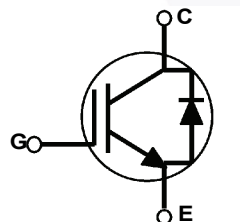
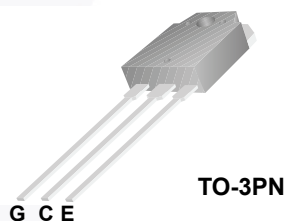
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.9\text{ V(Typ.)}$  @  $I_C = 40\text{ A}$
- Fast Switching :  $E_{OFF} = 6.5\text{ uJ/A}$
- Tighten Parameter Distribution
- RoHS Compliant

### Applications

- Solar Inverter, UPS, Welder, PFC, Induction Heating
- Telecom, ESS

### General Description

Using novel field stop IGBT technology, Fairchild's new series of field stop 2<sup>nd</sup> generation IGBTs offer the optimum performance for solar inverter, UPS, welder, induction heating, telecom, ESS and PFC applications where low conduction and switching losses are essential.



### Absolute Maximum Ratings

Symbol	Description	Ratings	Unit
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
	Transient Gate to Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100^\circ\text{C}$	40	A
$I_{CM(1)}$	Pulsed Collector Current	120	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ\text{C}$	40	A
	Diode Forward Current @ $T_C = 100^\circ\text{C}$	20	A
$I_{FM(1)}$	Pulsed Diode Maximum Forward Current	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	349	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	174	W
$T_J$	Operating Junction Temperature	-55 to +175	$^\circ\text{C}$
$T_{stg}$	Storage Temperature Range	-55 to +175	$^\circ\text{C}$
$T_L$	Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds	300	$^\circ\text{C}$

#### Notes:

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

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JC}(IGBT)$	Thermal Resistance, Junction to Case	-	0.43	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}(\text{Diode})$	Thermal Resistance, Junction to Case	-	1.5	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^{\circ}\text{C}/\text{W}$

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FGA40N65SMD	FGA40N65SMD	TO-3PN	Tube	N/A	N/A	30

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
BV <sub>CES</sub>	Collector to Emitter Breakdown Voltage	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	650	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	-	0.6	-	V/°C
I <sub>CES</sub>	Collector Cut-Off Current	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V	-	-	250	μA
I <sub>GES</sub>	G-E Leakage Current	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V	-	-	±400	nA
On Characteristics						
V <sub>GE(th)</sub>	G-E Threshold Voltage	I <sub>C</sub> = 250 μA, V <sub>CE</sub> = V <sub>GE</sub>	3.5	4.5	6.0	V
V <sub>CE(sat)</sub>	Collector to Emitter Saturation Voltage	I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	-	1.9	2.5	V
		I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 175°C	-	2.1	-	V
Dynamic Characteristics						
C <sub>ies</sub>	Input Capacitance	V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz	-	1880	-	pF
C <sub>oes</sub>	Output Capacitance		-	180	-	pF
C <sub>res</sub>	Reverse Transfer Capacitance		-	50	-	pF
Switching Characteristics						
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>CC</sub> = 400 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 6 Ω, V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 25°C	-	12	16	ns
t <sub>r</sub>	Rise Time		-	20	28	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	92	120	ns
t <sub>f</sub>	Fall Time		-	13	17	ns
E <sub>on</sub>	Turn-On Switching Loss		-	0.82	1.23	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.26	0.34	mJ
E <sub>ts</sub>	Total Switching Loss		-	1.08	1.57	mJ
t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>CC</sub> = 400 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 6 Ω, V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 175°C	-	15	-	ns
t <sub>r</sub>	Rise Time		-	22	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	116	-	ns
t <sub>f</sub>	Fall Time		-	16	-	ns
E <sub>on</sub>	Turn-On Switching Loss		-	1.08	-	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.60	-	mJ
E <sub>ts</sub>	Total Switching Loss		-	1.68	-	mJ

**Electrical Characteristics of the IGBT** (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$	-	119	180	nC
$Q_{ge}$	Gate to Emitter Charge		-	13	20	nC
$Q_{gc}$	Gate to Collector Charge		-	58	90	nC

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

Symbol	Parameter	Test Conditions		Min.	Typ.	Max	Unit
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> = 20 A	T <sub>C</sub> = 25°C	-	2.1	2.6	V
			T <sub>C</sub> = 175°C	-	1.7	-	
E <sub>rec</sub>	Reverse Recovery Energy	I <sub>F</sub> =20 A, di <sub>F</sub> /dt = 200 A/μs	T <sub>C</sub> = 175°C	-	96	-	μJ
t <sub>rr</sub>	Diode Reverse Recovery Time		T <sub>C</sub> = 25°C	-	42	-	ns
			T <sub>C</sub> = 175°C	-	200	-	
I <sub>rr</sub>	Diode Peak Reverse Recovery Current		T <sub>C</sub> = 25°C	-	3.6	-	A
			T <sub>C</sub> = 175°C	-	8.0	-	
Q <sub>rr</sub>	Diode Reverse Recovery Charge		T <sub>C</sub> = 25°C	-	76	-	nC
		T <sub>C</sub> = 175°C	-	800	-		

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

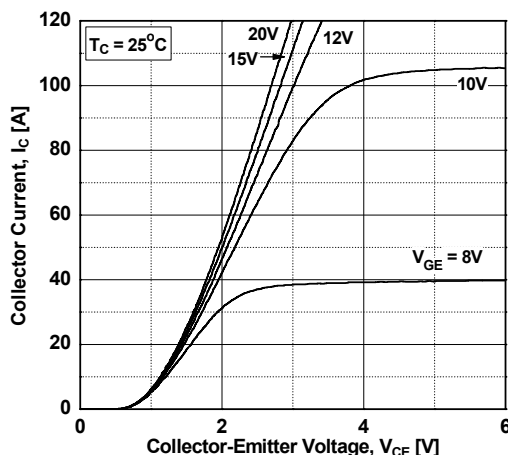


Figure 2. Typical Output Characteristics

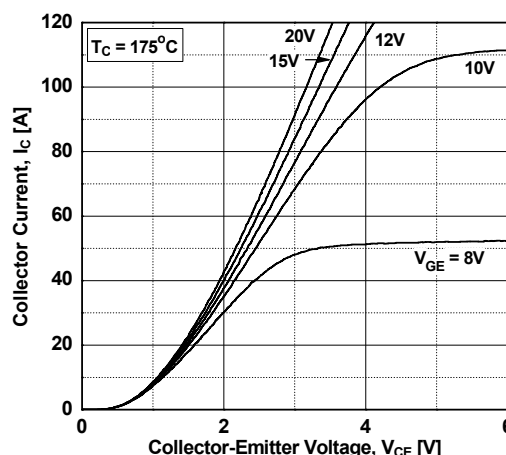


Figure 3. Typical Saturation Voltage Characteristics

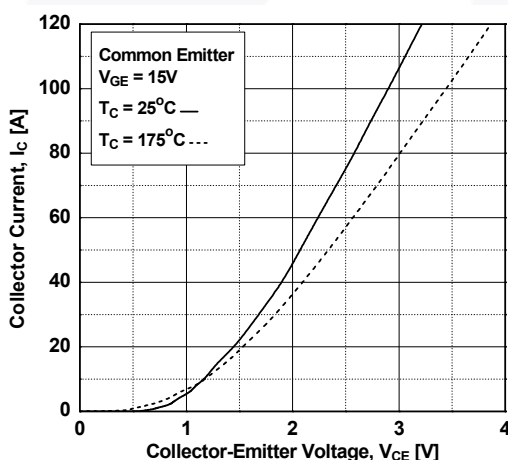


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

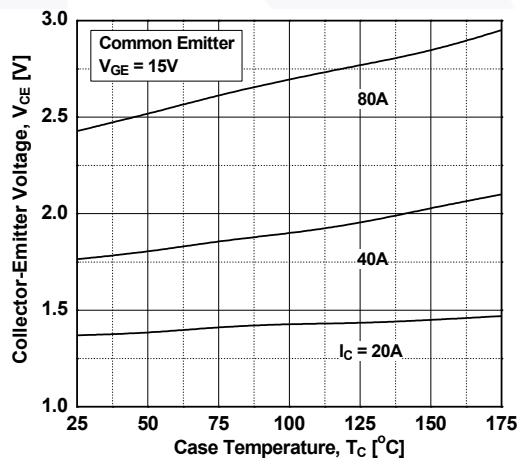


Figure 5. Saturation Voltage vs.  $V_{GE}$

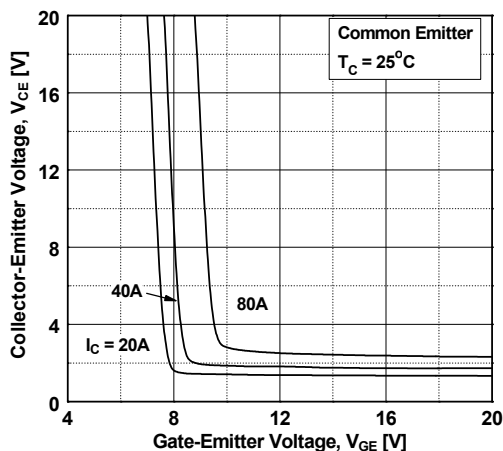
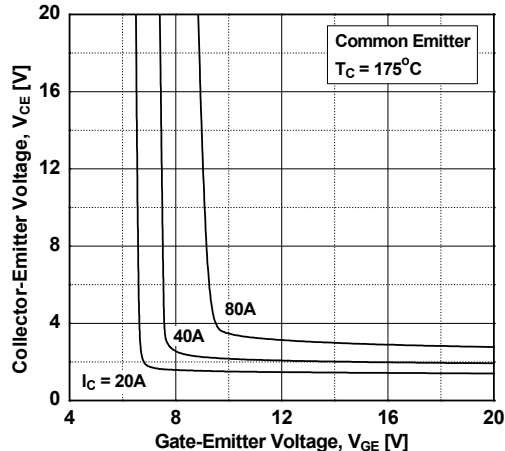


Figure 6. Saturation Voltage vs.  $V_{GE}$



## Typical Performance Characteristics

Figure 7. Capacitance Characteristics

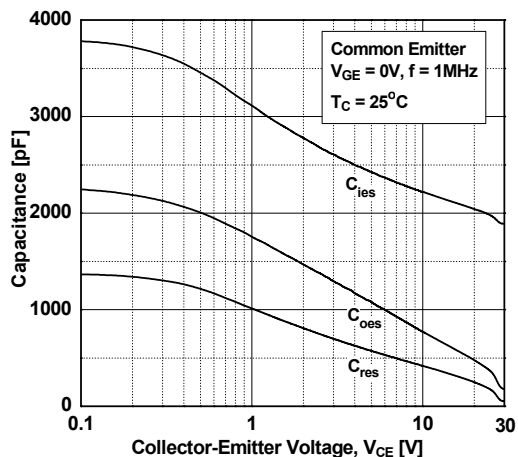


Figure 8. Gate charge Characteristics

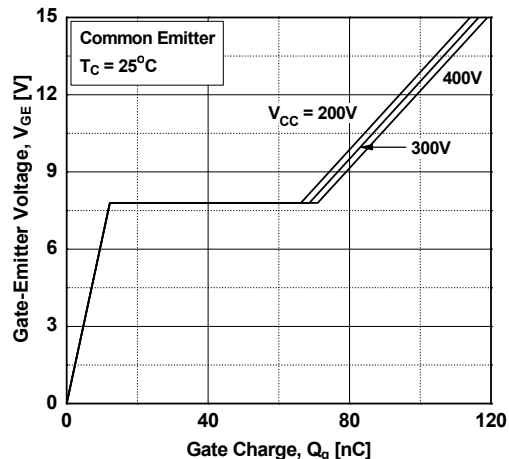


Figure 9. Turn-on Characteristics vs. Gate Resistance

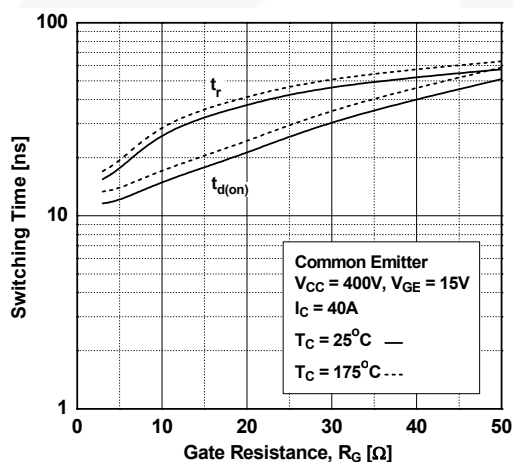


Figure 10. Turn-off Characteristics vs. Gate Resistance

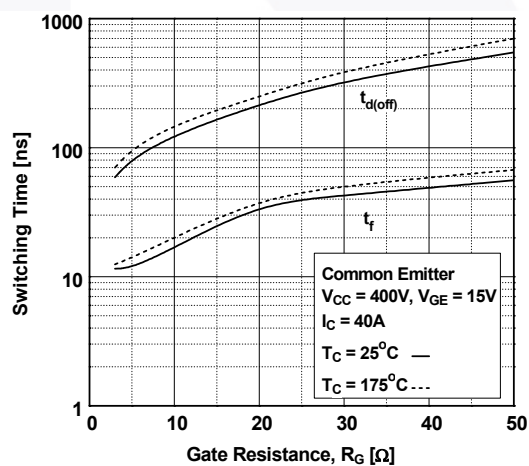


Figure 11. Switching Loss vs. Gate Resistance

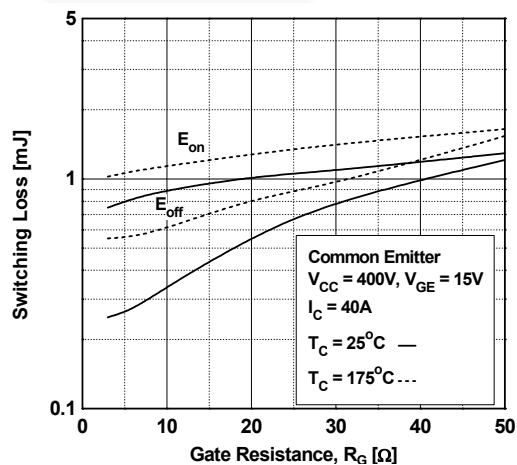
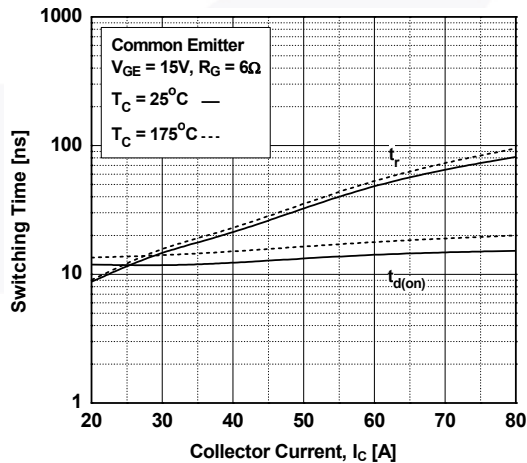


Figure 12. Turn-on Characteristics vs. Collector Current



## Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Collector Current

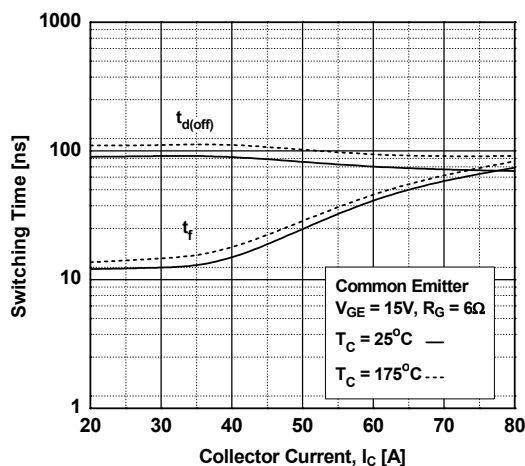


Figure 14. Switching Loss vs. Collector Current

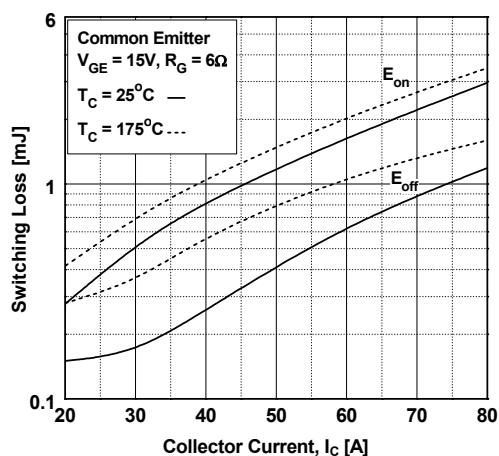


Figure 15. Load Current vs. Frequency

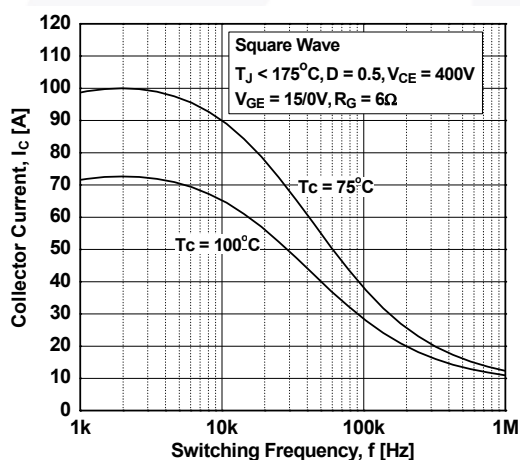


Figure 16. SOA Characteristics

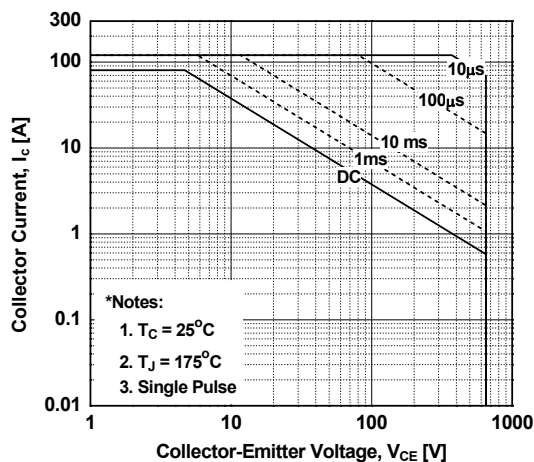


Figure 17. Forward Characteristics

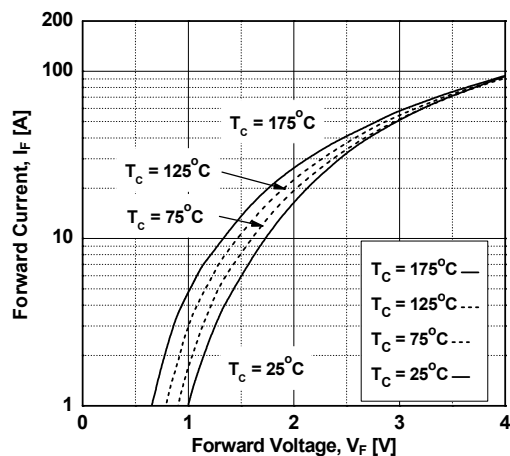
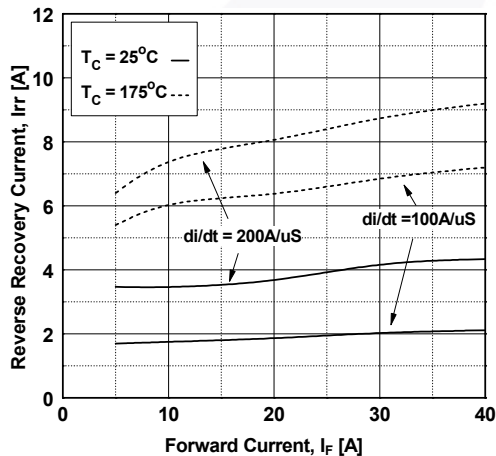


Figure 18. Reverse Recovery Current



## Typical Performance Characteristics

Figure 19. Reverse Recovery Time

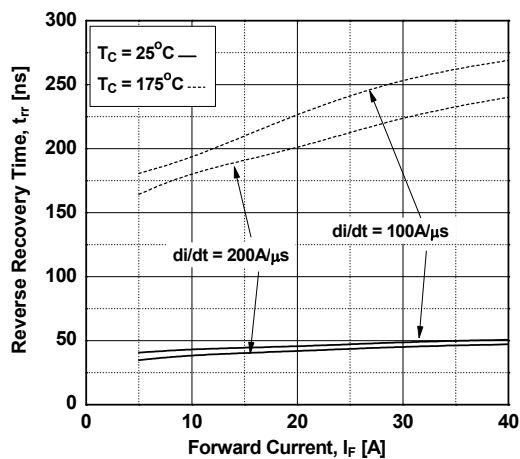


Figure 20. Stored Charge

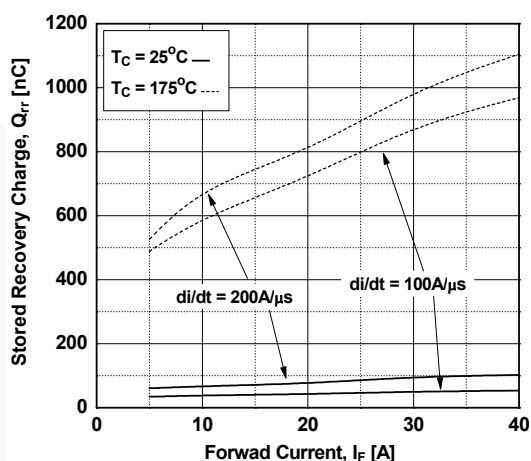


Figure 21. Transient Thermal Impedance of IGBT

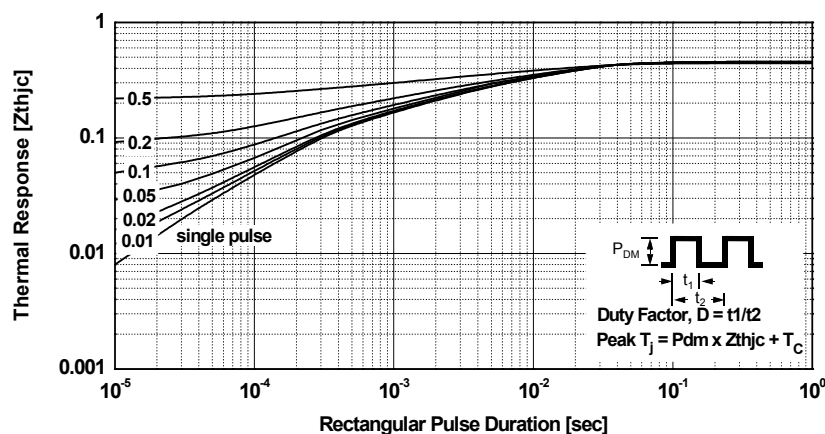
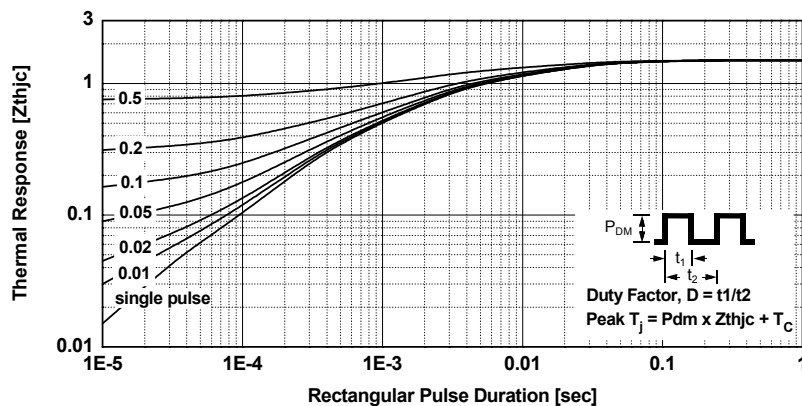
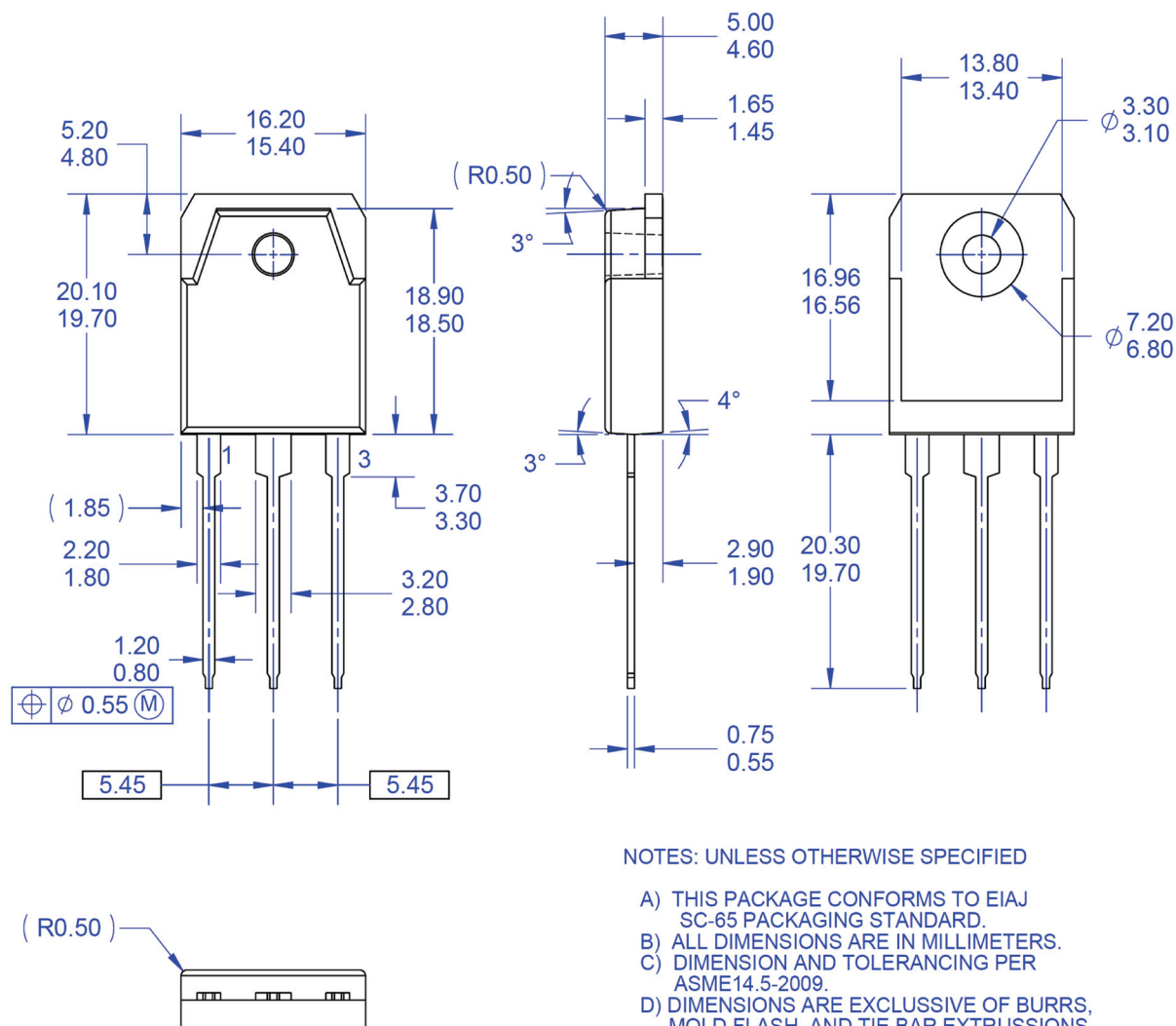


Figure 22. Transient Thermal Impedance of Diode



## Mechanical Dimensions



## NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO EIAJ SC-65 PACKAGING STANDARD.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSION AND TOLERANCING PER ASME14.5-2009.
- D) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- E) DRAWING FILE NAME: TO3PN03AREV1.
- F) FAIRCHILD SEMICONDUCTOR.

Figure 23. TO3PN, 3-Lead, Plastic, EIAJ SC-65

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