



# FGA60N65SMD

## 650 V, 60 A Field Stop IGBT

### Features

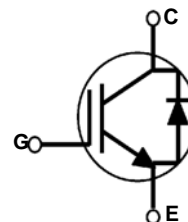
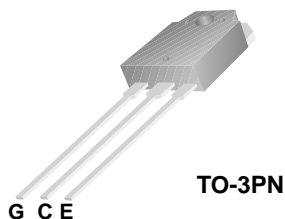
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.9\text{V(Typ.)}$  @  $I_C = 60\text{ A}$
- Fast Switching :  $E_{OFF} = 7.5\text{ uJ/A}$
- Tighten Parameter Distribution
- RoHS Compliant

### 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, telecom, ESS and PFC applications where low conduction and switching losses are essential.

### Applications

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



### Absolute Maximum Ratings

Symbol	Description	Ratings	Unit
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	120	A
	Collector Current @ $T_C = 100^\circ\text{C}$	60	A
$I_{CM(1)}$	Pulsed Collector Current	180	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ\text{C}$	60	A
	Diode Forward Current @ $T_C = 100^\circ\text{C}$	30	A
$I_{FM(1)}$	Pulsed Diode Maximum Forward Current	180	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	600	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	300	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	-	0.25	$^{\circ}C/W$
$R_{\theta JC}(Diode)$	Thermal Resistance, Junction to Case	-	1.1	$^{\circ}C/W$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^{\circ}C/W$

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FGA60N65SMD	FGA60N65SMD	TO-3PN	-	-	30

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Off Characteristics</b>						
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	650	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	-	0.6	-	$V/^{\circ}C$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0V$	-	-	250	$\mu A$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0V$	-	-	$\pm 400$	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250\mu A, V_{CE} = V_{GE}$	3.5	4.5	6.0	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 60A, V_{GE} = 15V$	-	1.9	2.5	V
		$I_C = 60A, V_{GE} = 15V, T_C = 175^{\circ}C$	-	2.1	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	-	2915	-	pF
$C_{oes}$	Output Capacitance		-	270	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	85	-	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 60A, R_G = 3\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^{\circ}C$	-	18	27	ns
$t_r$	Rise Time		-	47	70	ns
$t_{d(off)}$	Turn-Off Delay Time		-	104	146	ns
$t_f$	Fall Time		-	50	68	ns
$E_{on}$	Turn-On Switching Loss		-	1.54	2.31	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.45	0.60	mJ
$E_{ts}$	Total Switching Loss		-	1.99	2.91	mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 60A, R_G = 3\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 175^{\circ}C$	-	18	-	ns
$t_r$	Rise Time		-	41	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	115	-	ns
$t_f$	Fall Time		-	48	-	ns
$E_{on}$	Turn-On Switching Loss		-	2.08	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.78	-	mJ
$E_{ts}$	Total Switching Loss		-	2.86	-	mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
$Q_g$	Total Gate Charge	$V_{CE} = 400V, I_C = 60A,$ $V_{GE} = 15V$	-	189	284	nC
$Q_{ge}$	Gate to Emitter Charge		-	20	30	nC
$Q_{gc}$	Gate to Collector Charge		-	91	137	nC

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit	
$V_{FM}$	Diode Forward Voltage	$I_F = 30A$	$T_C = 25^\circ C$	-	2.1	2.6	V
			$T_C = 175^\circ C$	-	1.7	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 30A,$ $di_F/dt = 200A/\mu s$	$T_C = 175^\circ C$	-	127	-	$\mu J$
$t_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ C$	-	47	-	ns
			$T_C = 175^\circ C$	-	212	-	
$I_{rr}$	Diode Peak Reverse Recovery Current		$T_C = 25^\circ C$	-	3.7	-	A
			$T_C = 175^\circ C$	-	8.8	-	
$Q_{rr}$	Diode Reverse Recovery Charge	$T_C = 25^\circ C$	-	87	-	nC	
		$T_C = 175^\circ C$	-	933	-		

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

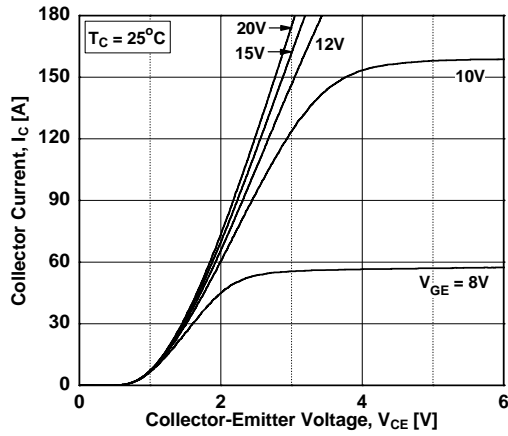


Figure 2. Typical Output Characteristics

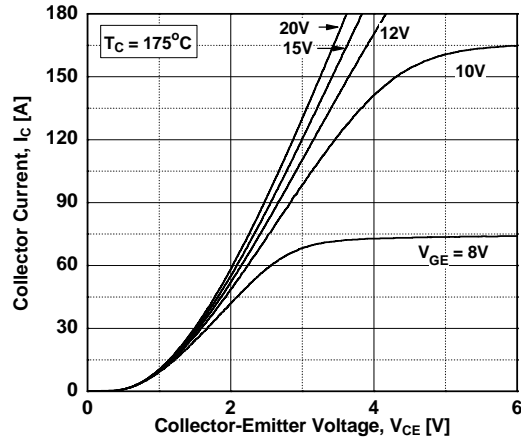


Figure 3. Typical Saturation Voltage Characteristics

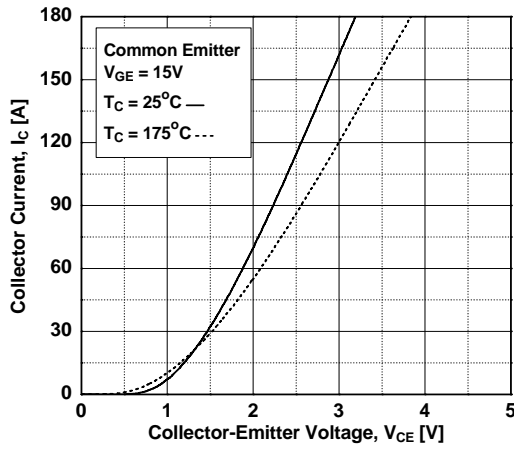


Figure 4. Transfer Characteristics

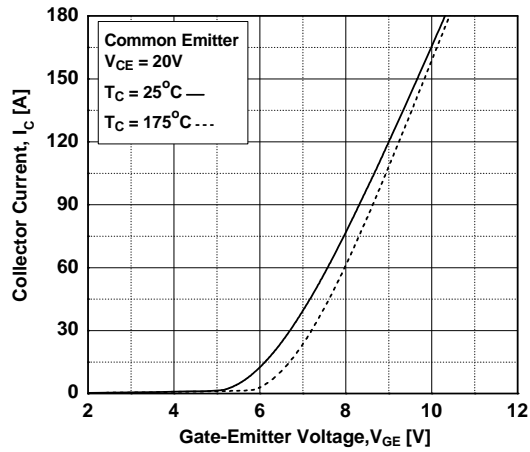


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

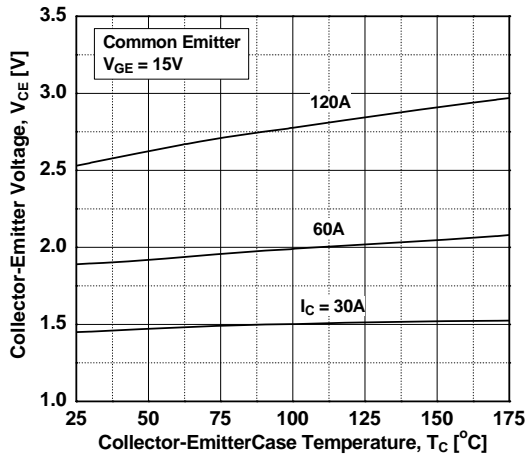
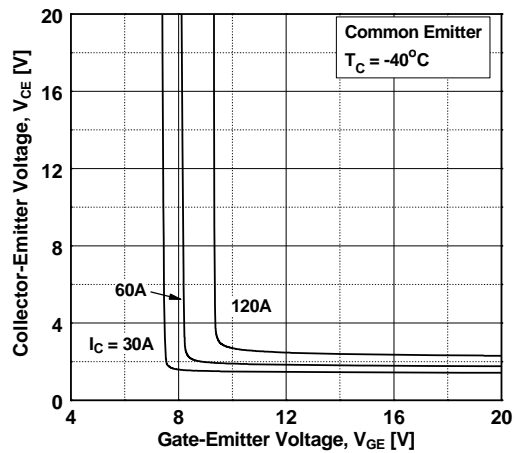


Figure 6. Saturation Voltage vs. Vge



## Typical Performance Characteristics

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

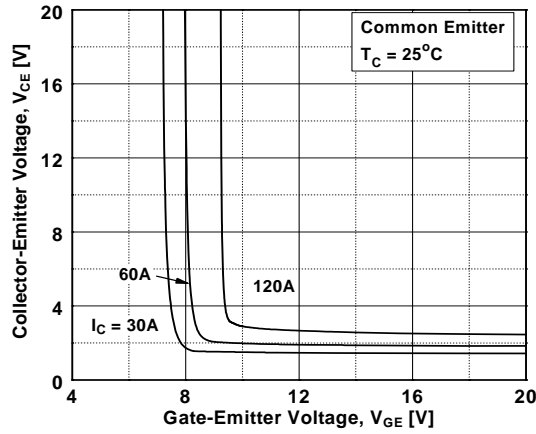


Figure 8. Saturation Voltage vs.  $V_{GE}$

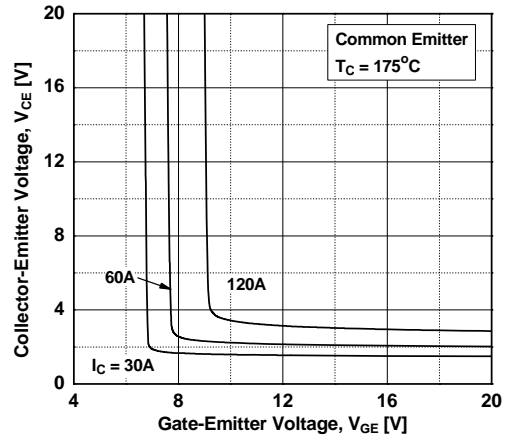


Figure 9. Capacitance Characteristics

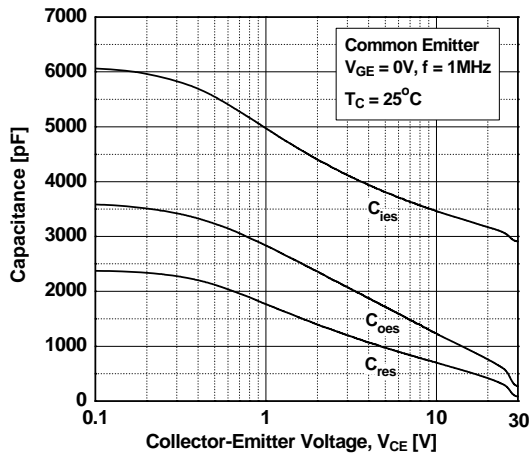


Figure 10. Gate charge Characteristics

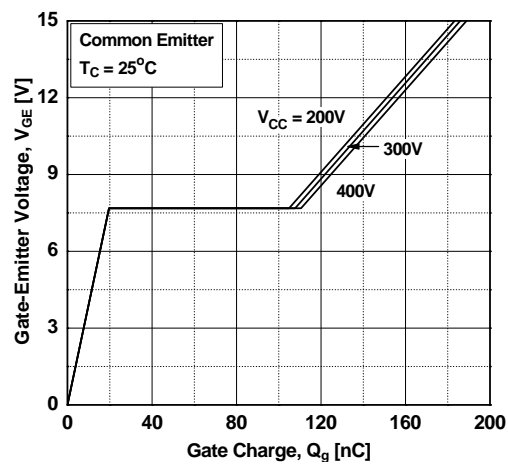


Figure 11. SOA Characteristics

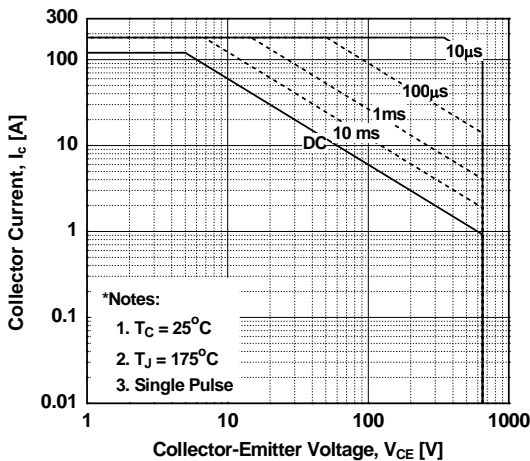
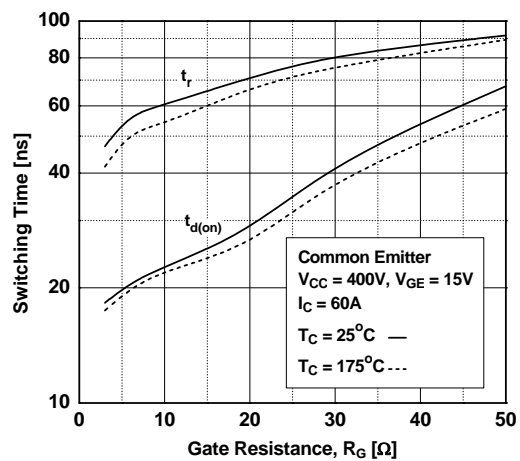
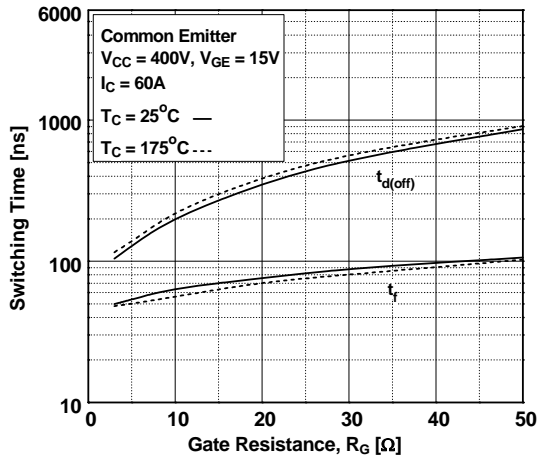


Figure 12. Turn-on Characteristics vs. Gate Resistance

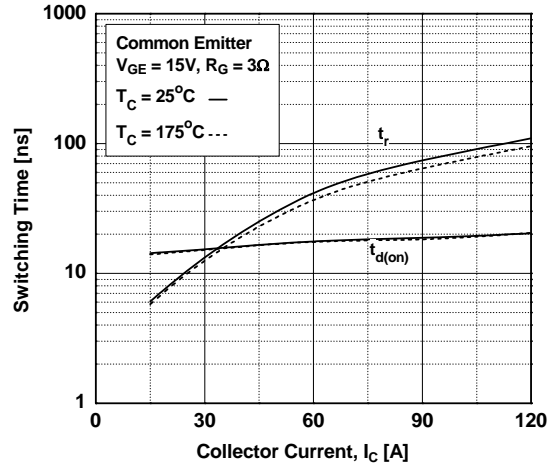


## Typical Performance Characteristics

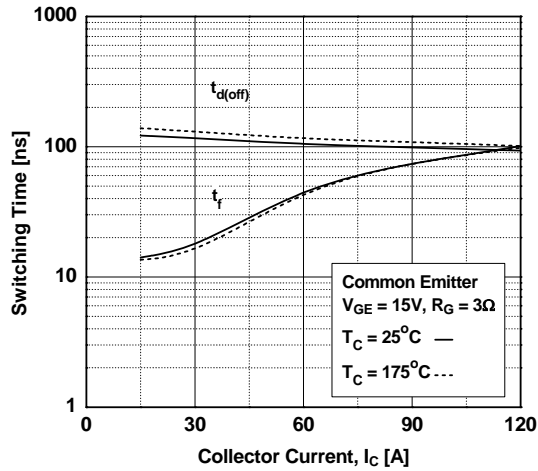
**Figure 13. Turn-off Characteristics vs. Gate Resistance**



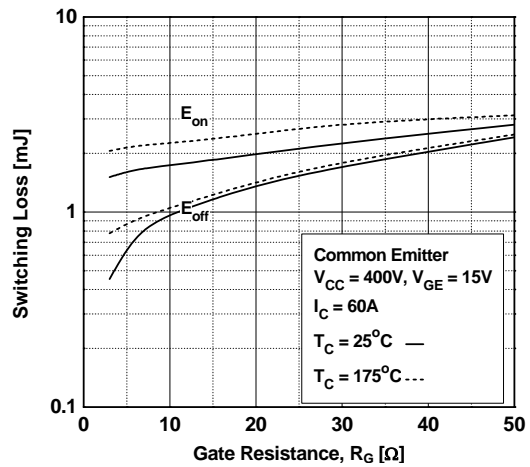
**Figure 14. Turn-on Characteristics vs. Collector Current**



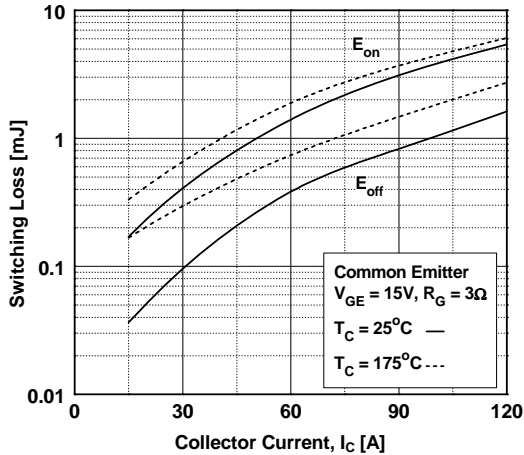
**Figure 15. Turn-off Characteristics vs. Collector Current**



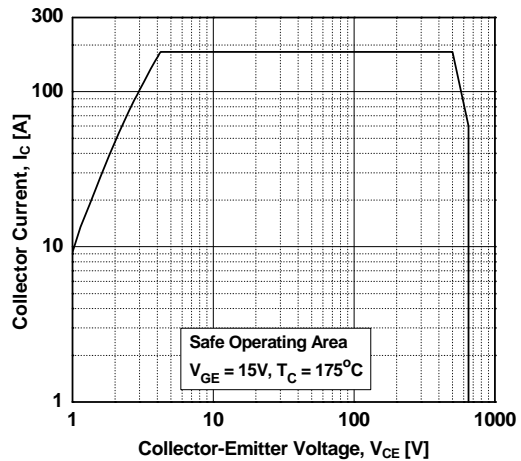
**Figure 16. Switching Loss vs. Gate Resistance**



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



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



## Typical Performance Characteristics

Figure 19. Current Derating

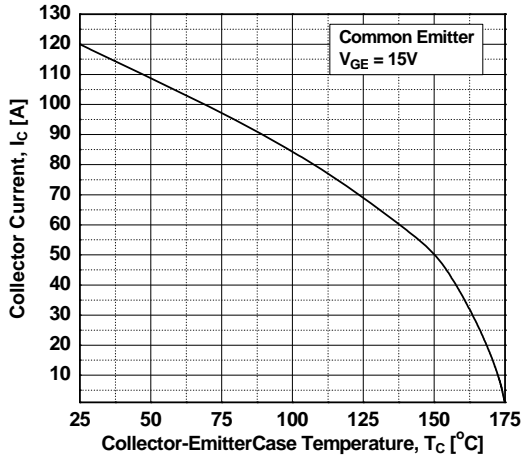


Figure 20. Load Current Vs. Frequency

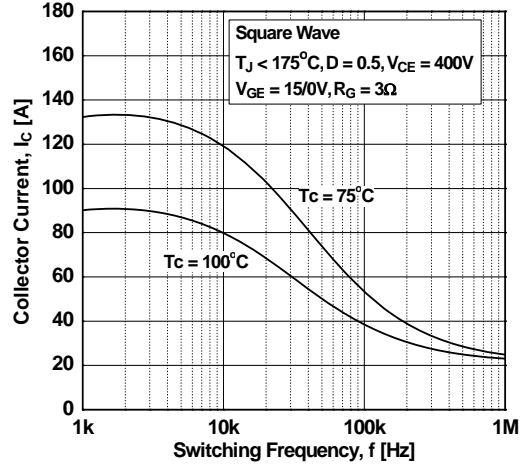


Figure 21. Forward Characteristics

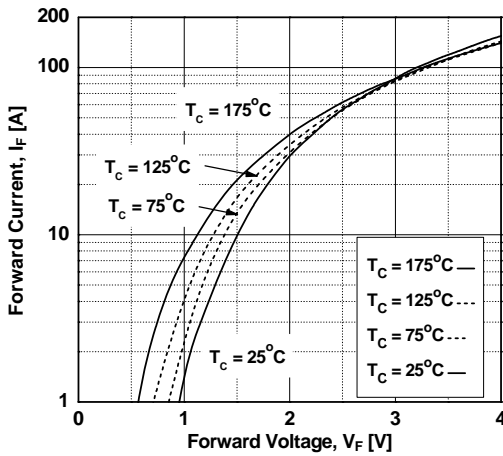


Figure 22. Reverse Recovery Current

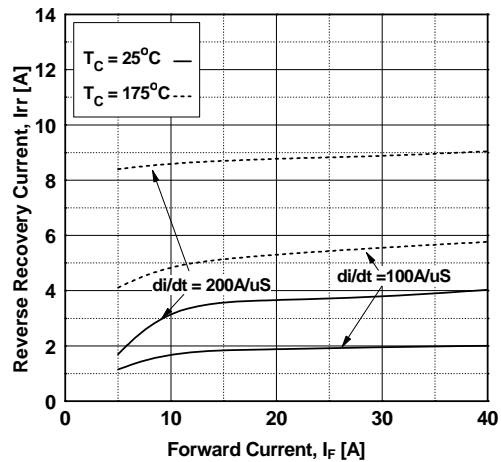


Figure 23. Stored Charge

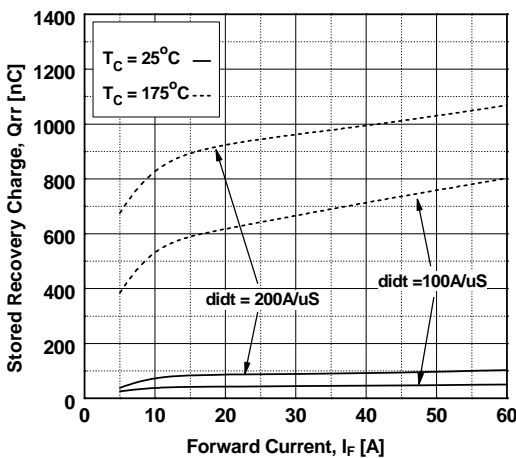
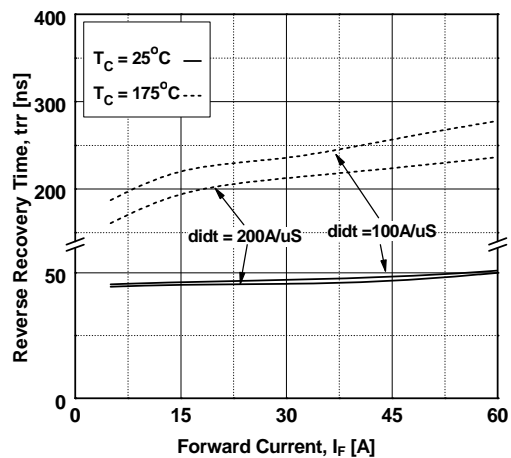


Figure 24. Reverse Recovery Time



Typical Performance Characteristics

Figure 25. Transient Thermal Impedance of IGBT

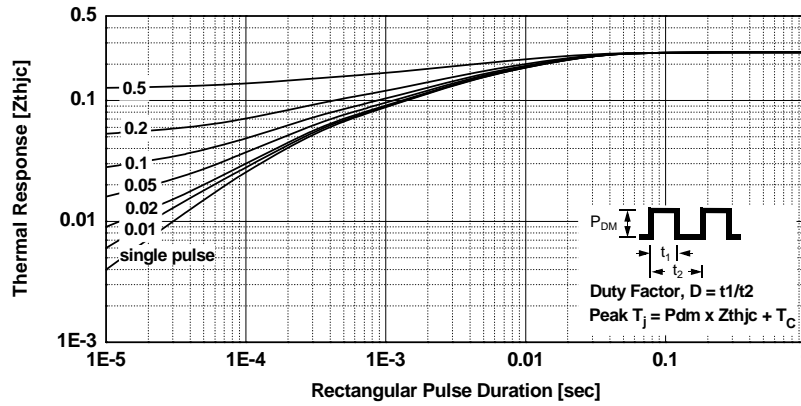
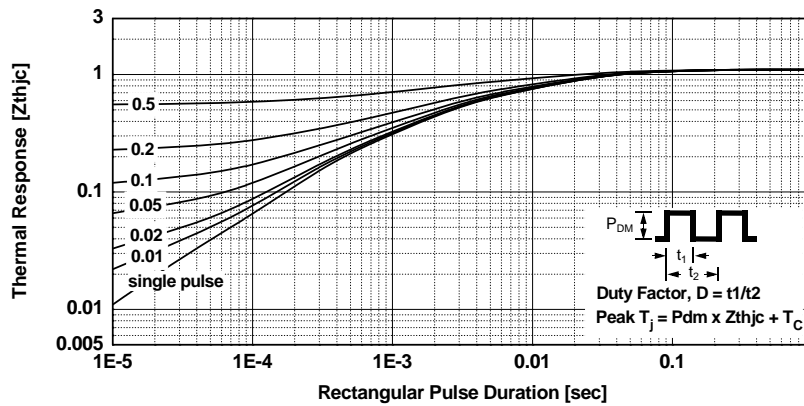


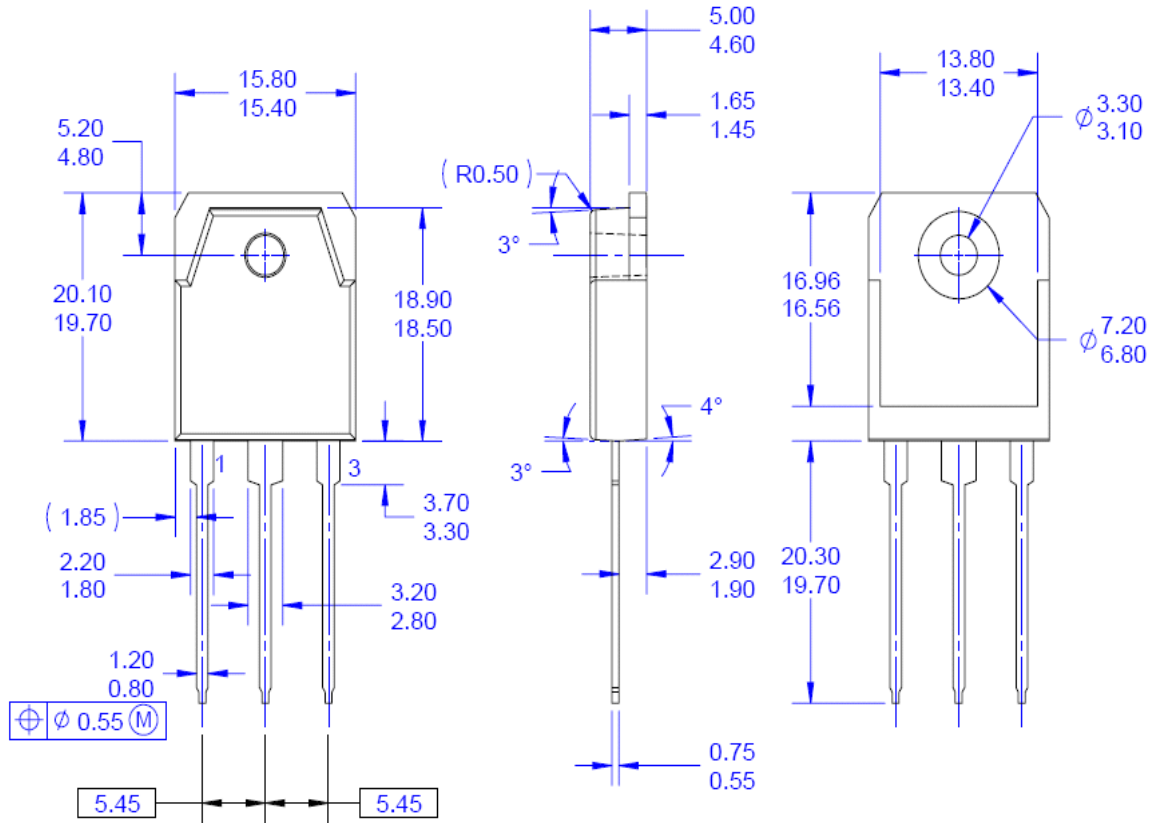
Figure 26. Transient Thermal Impedance of Diode





## Mechanical Dimensions

### TO-3PN







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- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSION AND TOLERANCING PER ASME14.5
- D) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- E) THIS PACKAGE IS INTENDED ONLY FOR TO3PN.
- F) DRAWING FILE NAME: TO3P03AREV4.



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Datasheet Identification	Product Status	Definition
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Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. 164



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