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# FGH40N60SMDF

## 600 V, 40 A Field Stop IGBT

### Features

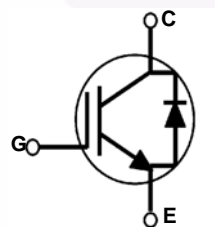
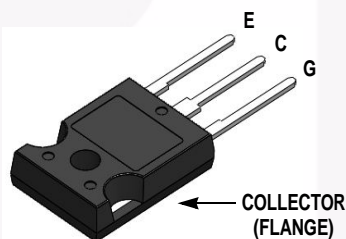
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.9\text{ V(Typ.) @ } I_C = 40\text{ A}$
- High Input Impedance
- Fast Switching:  $E_{OFF} = 6.5\text{ uJ/A}$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

### Applications

- Solar Inverter, UPS, Welder, PFC, 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, 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	600	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	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 @ $T_C = 25^\circ\text{C}$	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
$R_{\theta JC}(\text{IGBT})$	Thermal Resistance, Junction to Case	-	0.43	$^\circ\text{C/W}$
$R_{\theta JC}(\text{Diode})$	Thermal Resistance, Junction to Case	-	1.45	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^\circ\text{C/W}$

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FGH40N60SMDF	FGH40N60SMDF	TO-247	Tube	N/A	N/A	30

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Off Characteristics</b>						
BV <sub>CES</sub>	Collector to Emitter Breakdown Voltage	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	600	-	-	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
<b>On Characteristics</b>						
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	4.6	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> = 150°C	-	2.1	-	V
<b>Dynamic Characteristics</b>						
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
<b>Switching Characteristics</b>						
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	-	ns
t <sub>r</sub>	Rise Time		-	20	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	92	-	ns
t <sub>f</sub>	Fall Time		-	13	20	ns
E <sub>on</sub>	Turn-On Switching Loss		-	1.3	-	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.26	-	mJ
E <sub>ts</sub>	Total Switching Loss		-	1.56	-	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> = 150°C	-	12	-	ns
t <sub>r</sub>	Rise Time		-	19	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	97	-	ns
t <sub>f</sub>	Fall Time		-	14	21	ns
E <sub>on</sub>	Turn-On Switching Loss		-	2.09	-	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.44	-	mJ
E <sub>ts</sub>	Total Switching Loss		-	2.53	-	mJ
Q <sub>g</sub>	Total Gate Charge	V <sub>CE</sub> = 400 V, I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	-	119	-	nC
Q <sub>ge</sub>	Gate to Emitter Charge		-	13	-	nC
Q <sub>gc</sub>	Gate to Collector Charge		-	58	-	nC

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit	
$V_{FM}$	Diode Forward Voltage	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	1.3	1.7	V
			$T_C = 150^\circ\text{C}$	-	1.2		
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 25^\circ\text{C}$	-	70	90	ns
			$T_C = 150^\circ\text{C}$	-	126		
$Q_{rr}$	Diode Reverse Recovery Charge	$I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 25^\circ\text{C}$	-	207	290	nC
			$T_C = 150^\circ\text{C}$	-	638		



## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

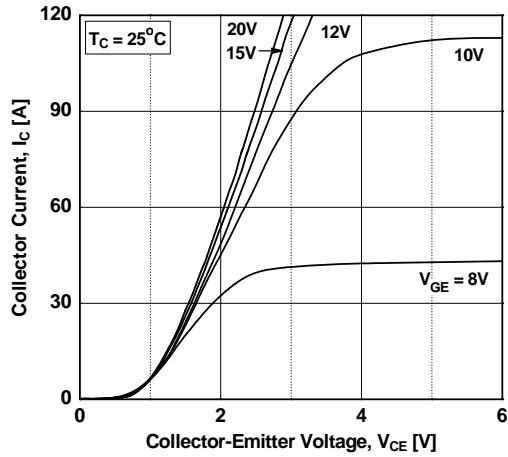


Figure 2. Typical Output Characteristics

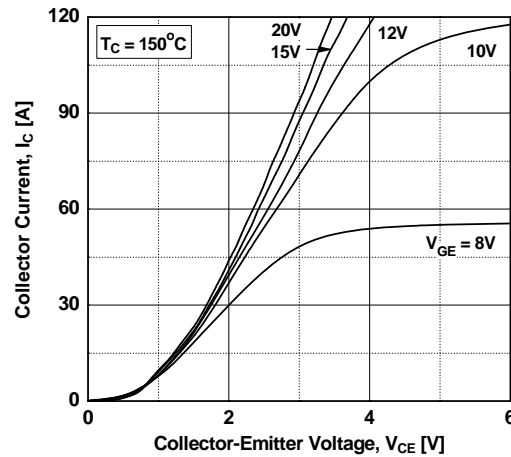


Figure 3. Typical Saturation Voltage Characteristics

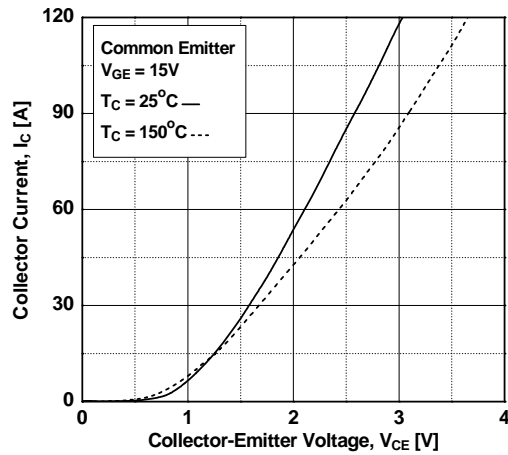


Figure 4. Transfer Characteristics

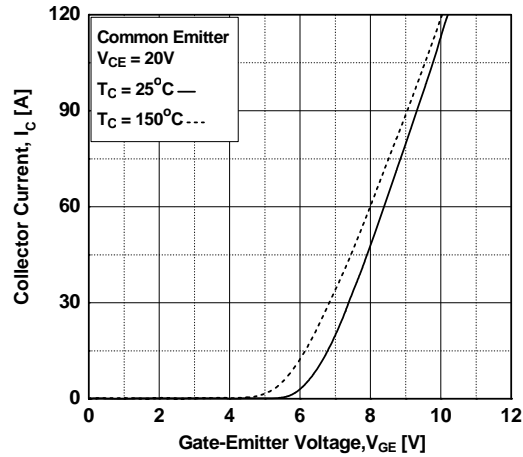


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

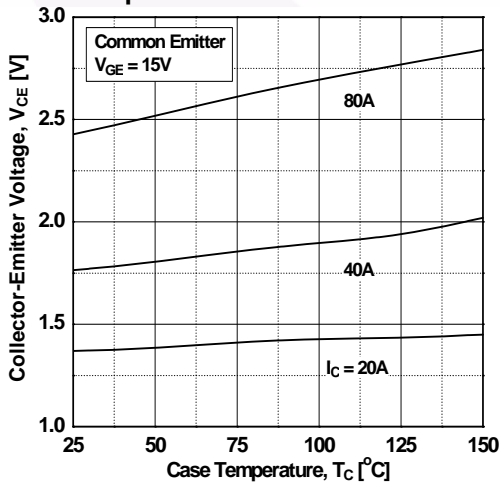
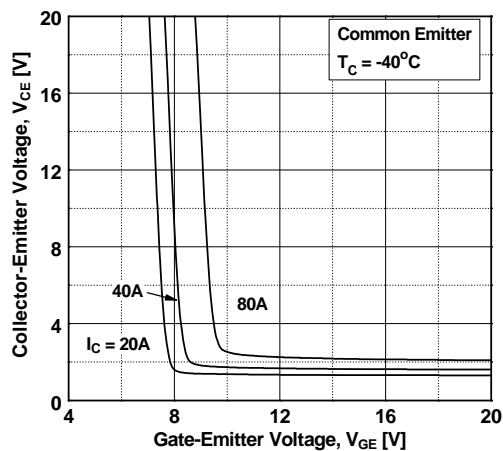


Figure 6. Saturation Voltage vs. Vge



## Typical Performance Characteristics

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

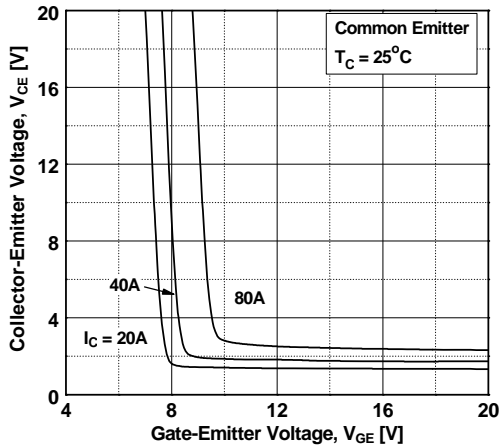


Figure 8. Saturation Voltage vs.  $V_{GE}$

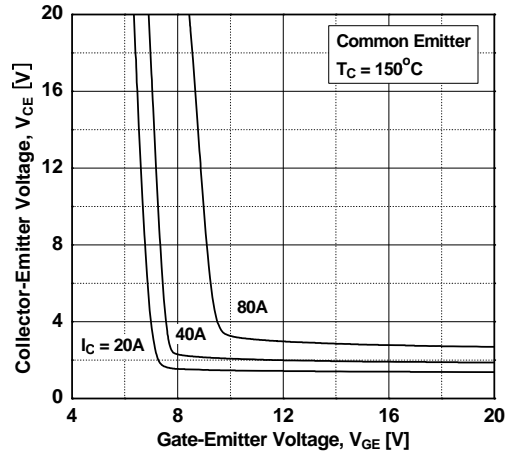


Figure 9. Capacitance Characteristics

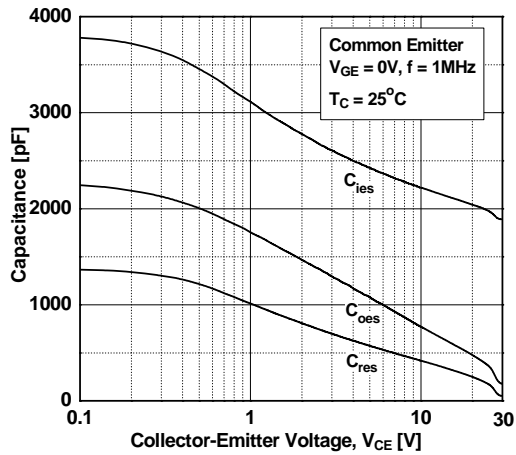


Figure 10. Gate charge Characteristics

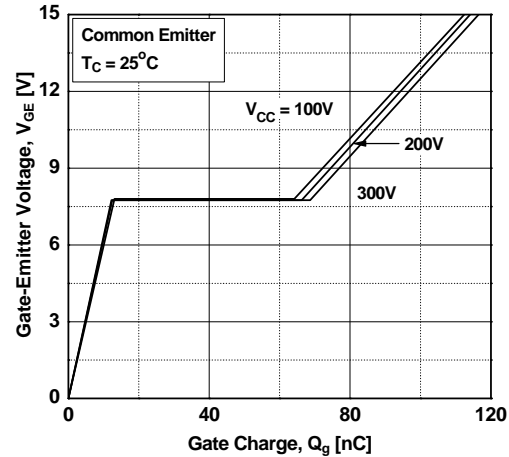


Figure 11. SOA Characteristics

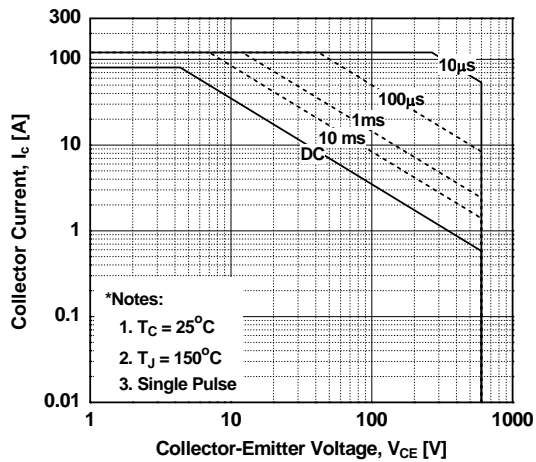
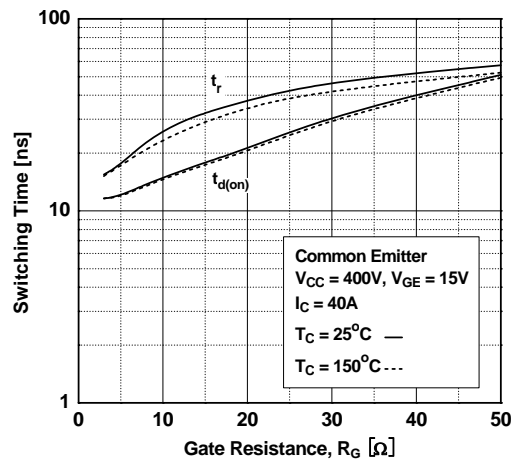
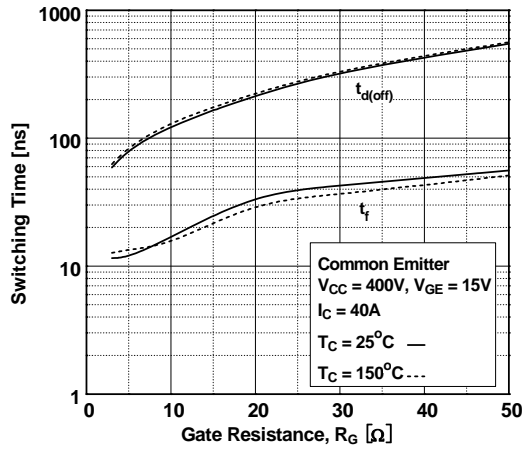


Figure 12. Turn-on Characteristics vs. Gate Resistance

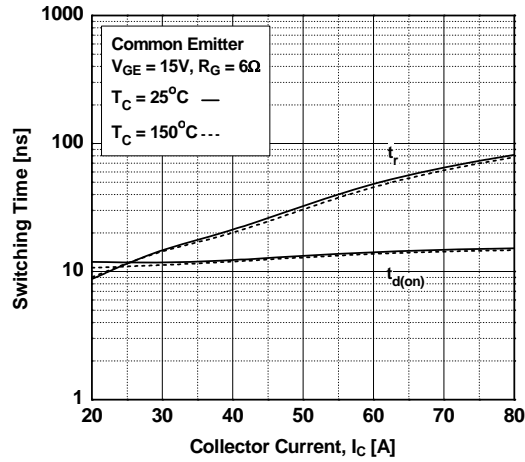


## Typical Performance Characteristics

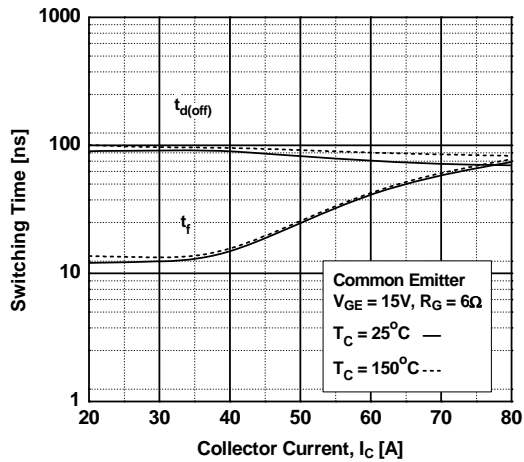
**Figure 13. Turn-off Characteristics vs. Gate Resistance**



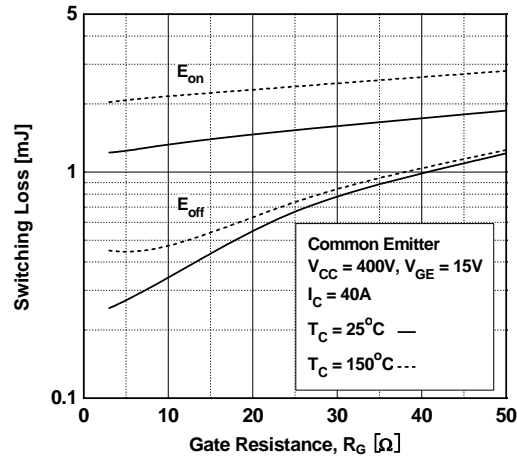
**Figure 14. Turn-on Characteristics vs. Collector Current**



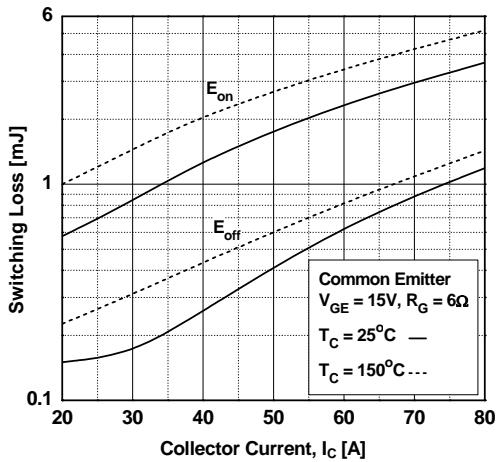
**Figure 15. Turn-off Characteristics vs. Collector Current**



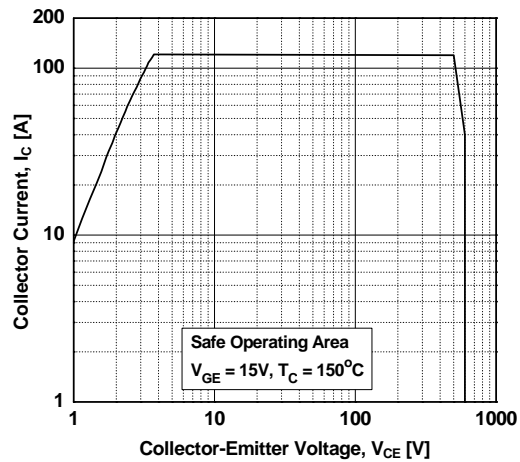
**Figure 16. Switching Loss vs. Gate Resistance**



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



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



## Typical Performance Characteristics

Figure 19. Forward Characteristics

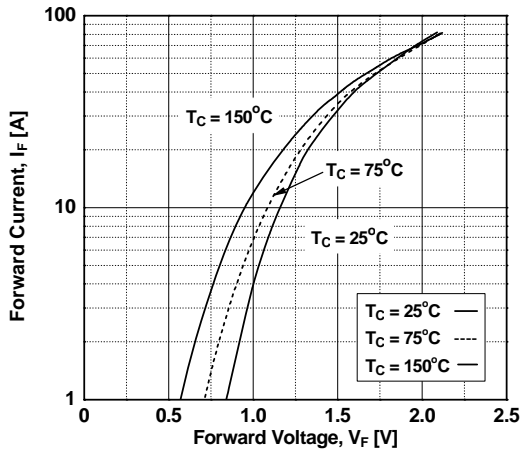


Figure 20. Reverse Current

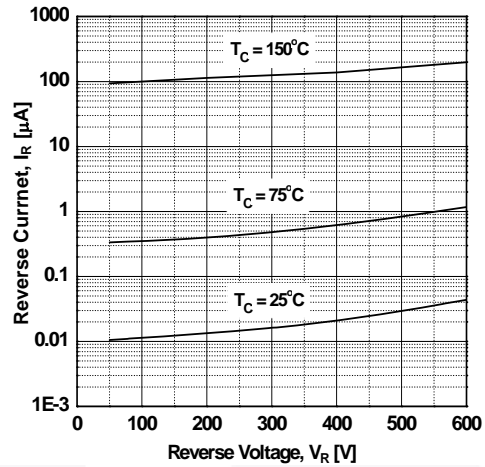


Figure 21. Stored Charge

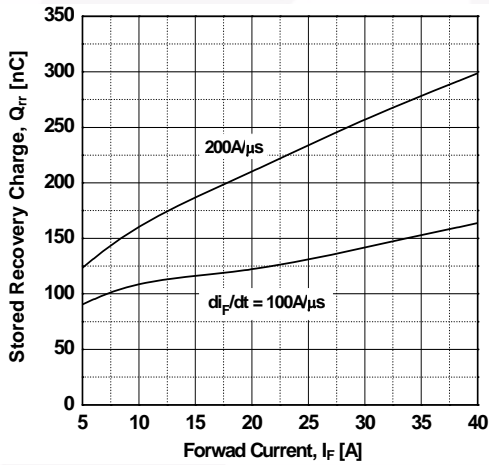


Figure 22. Reverse Recovery Time

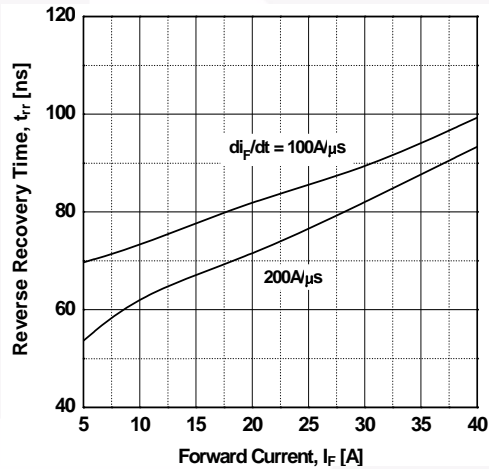
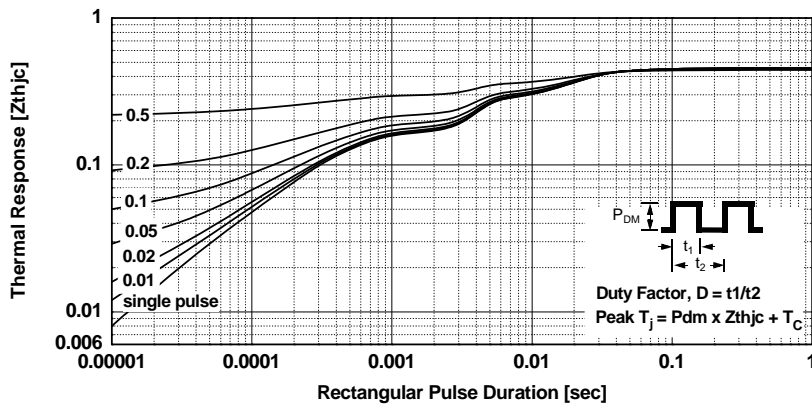
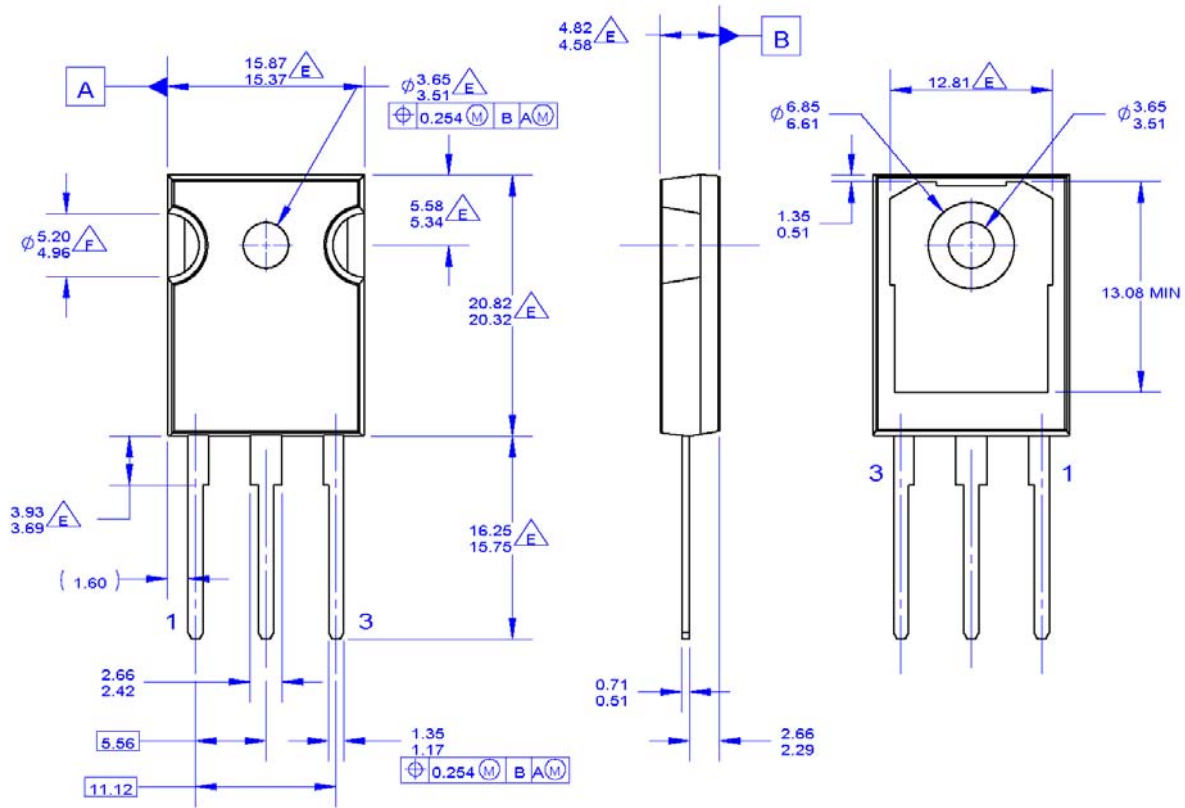


Figure 23. Transient Thermal Impedance of IGBT





Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. PACKAGE REFERENCE: JEDEC TO-247, ISSUE E, VARIATION AB, DATED JUNE, 2004.
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DRAWING CONFORMS TO ASME Y14.5 - 1994
- $\triangle E$  DOES NOT COMPLY JEDEC STANDARD VALUE
- $\triangle F$  NOTCH MAY BE SQUARE
- G. DRAWING FILENAME: MKT-TO247A03\_REV03

Figure 24. TO-247 3L - TO-247,MOLDED,3 LEAD,JEDEC VARIATION AB

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| AX-CAP®*                                                                          | FRFET®                                          | PowerXS™                              | SYSTEM®*                                                                            |
| BitSiC™                                                                           | Global Power Resource <sup>SM</sup>             | Programmable Active Droop™            | TinyBoost®                                                                          |
| Build it Now™                                                                     | GreenBridge™                                    | QFET®                                 | TinyBuck®                                                                           |
| CorePLUS™                                                                         | Green FPS™                                      | QS™                                   | TinyCalc™                                                                           |
| CorePOWER™                                                                        | Green FPS™ e-Series™                            | Quiet Series™                         | TinyLogic®                                                                          |
| CROSSVOLT™                                                                        | Gmax™                                           | RapidConfigure™                       | TINYOPTO™                                                                           |
| CTL™                                                                              | GTO™                                            | TM                                    | TinyPower™                                                                          |
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|  | MicroPak™                                       | STEALTH™                              |  |
| Fairchild®                                                                        | MicroPak2™                                      | SuperFET®                             | UHC®                                                                                |
| Fairchild Semiconductor®                                                          | MillerDrive™                                    | SuperSOT™-3                           | Ultra FRFET™                                                                        |
| FACT Quiet Series™                                                                | MotionMax™                                      | SuperSOT™-6                           | UniFET™                                                                             |
| FACT®                                                                             | mWSaver®                                        | SuperSOT™-8                           | VCX™                                                                                |
| FAST®                                                                             | OptoHiT™                                        | SupreMOS®                             | VisualMax™                                                                          |
| FastvCore™                                                                        | OPTOLOGIC®                                      | SyncFET™                              | VoltagePlus™                                                                        |
| FETBench™                                                                         | OPTOPLANAR®                                     |                                       | XS™                                                                                 |
| FPS™                                                                              |                                                 |                                       |                                                                                     |

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