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# FGH40T65UPD

## 650 V, 40 A Field Stop Trench IGBT

### Features

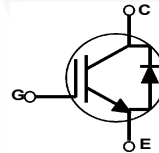
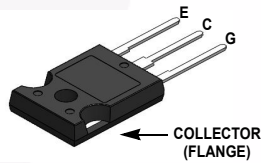
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.65 \text{ V(Typ.)} @ I_C = 40 \text{ A}$
- 100% of Parts Tested  $I_{LM(2)}$
- High Input Impedance
- Tightened Parameter Distribution
- RoHS Compliant
- Short Circuit Ruggedness  $> 5 \text{ us} @ 25^\circ\text{C}$

### General Description

Using innovative field stop trench IGBT technology, Fairchild's new series of field-stop trench IGBTs offer optimum performance for solar inverter, UPS, welder, and digital power generator where low conduction and switching losses are essential.

### Applications

- Solar Inverter, UPS, Welder, Digital Power Generator
- 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
	Transient Gate to Emitter Voltage	$\pm 25$	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
$I_{LM(2)}$	Clamped Inductive Load Current @ $T_C = 25^\circ\text{C}$	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 @ $T_C = 25^\circ\text{C}$	268	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	134	W
SCWT	Short Circuit Withstand Time @ $T_C = 25^\circ\text{C}$	5	us
$T_J$	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
- 2:  $I_C = 120 \text{ A}$ ,  $V_{CE} = 400 \text{ V}$ ,  $R_g = 15 \Omega$

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JC}(\text{IGBT})$	Thermal Resistance, Junction to Case	-	0.56	$^\circ\text{C/W}$
$R_{\theta JC}(\text{Diode})$	Thermal Resistance, Junction to Case	-	1.71	$^\circ\text{C/W}$
$R_{\theta JA}$	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
FGH40T65UPD	FGH40T65UPD	TO-247 A03	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> = 1 mA	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 $\mu$ A	-	0.65	-	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	$\mu$ A
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> = 40 mA, V <sub>CE</sub> = V <sub>GE</sub>	4.0	6.0	7.5	V
V <sub>CE(sat)</sub>	Collector to Emitter Saturation Voltage	I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	-	1.65	2.3	V
		I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 175°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	-	2730	3630	pF
C <sub>oes</sub>	Output Capacitance		-	82	110	pF
C <sub>res</sub>	Reverse Transfer Capacitance		-	48	72	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> = 7 $\Omega$ , V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 25°C	-	20	26	ns
t <sub>r</sub>	Rise Time		-	26	34	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	144	187	ns
t <sub>f</sub>	Fall Time		-	17	22	ns
E <sub>on</sub>	Turn-On Switching Loss		-	1.59	2.1	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.58	0.76	mJ
E <sub>ts</sub>	Total Switching Loss	-	2.17	2.86	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> = 7 $\Omega$ , V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 175°C	-	19	-	ns
t <sub>r</sub>	Rise Time		-	38	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	153	-	ns
t <sub>f</sub>	Fall Time		-	60	-	ns
E <sub>on</sub>	Turn-On Switching Loss		-	1.84	-	mJ
E <sub>off</sub>	Turn-Off Switching Loss		-	0.98	-	mJ
E <sub>ts</sub>	Total Switching Loss	-	2.82	-	mJ	
T <sub>SC</sub>	Short Circuit Withstand Time	V <sub>GE</sub> = 15 V, V <sub>CC</sub> = 400 V, R <sub>G</sub> = 10 $\Omega$	5	-	-	us
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	-	177	265	nC
Q <sub>ge</sub>	Gate to Emitter Charge		-	23	35	nC
Q <sub>gc</sub>	Gate to Collector Charge		-	100	150	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	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	2.1	2.7	V
			$T_C = 175^\circ\text{C}$	-	1.9	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 175^\circ\text{C}$	-	96	-	$\mu\text{J}$
$t_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ\text{C}$	-	33	43	ns
			$T_C = 175^\circ\text{C}$	-	128	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ\text{C}$	-	53	74	nC
		$T_C = 175^\circ\text{C}$	-	341	-		

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

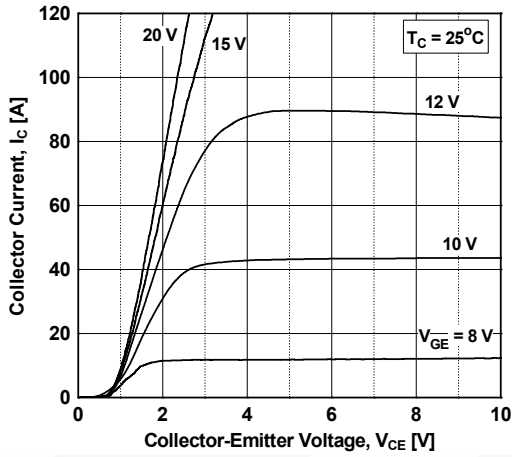


Figure 2. Typical Output Characteristics

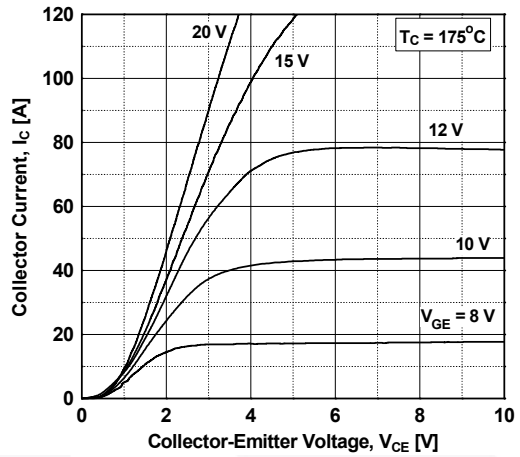


Figure 3. Typical Saturation Voltage Characteristics

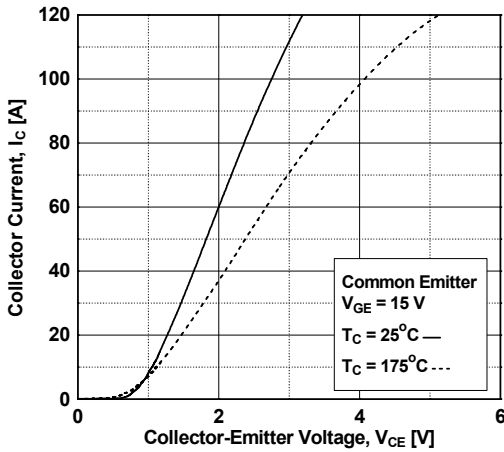


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

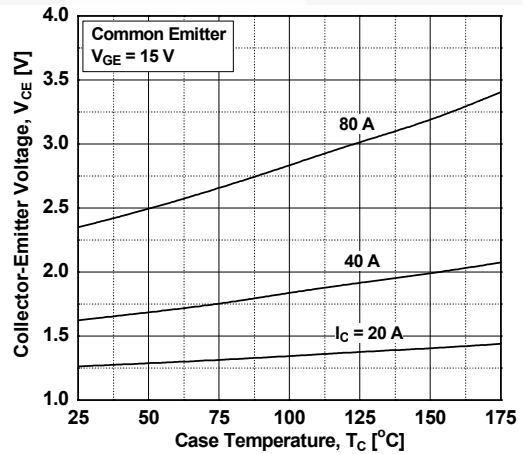


Figure 5. Saturation Voltage vs. Vge

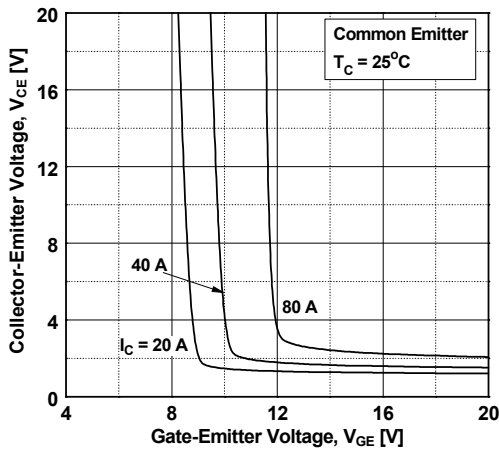
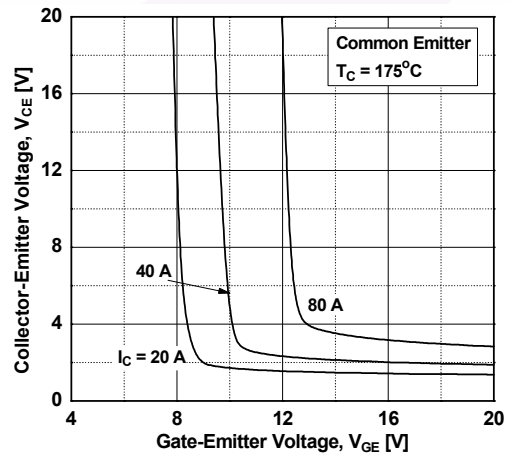


Figure 6. Saturation Voltage vs. Vge



## Typical Performance Characteristics

Figure 7. Capacitance Characteristics

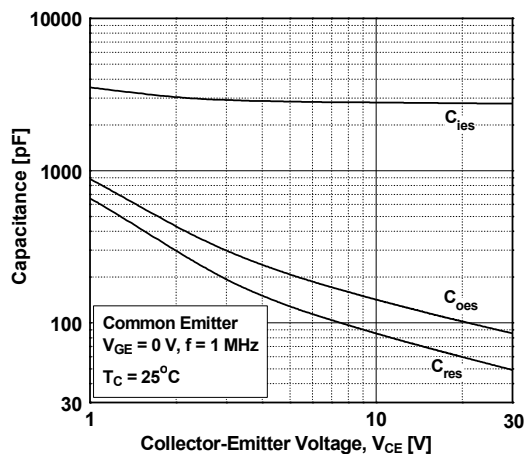


Figure 8. Gate charge Characteristics

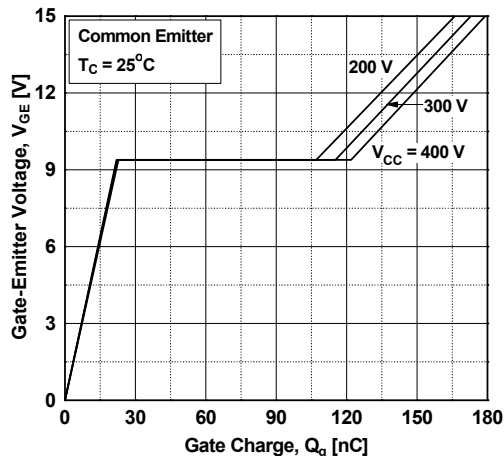


Figure 9. Turn-on Characteristics vs. Gate Resistance

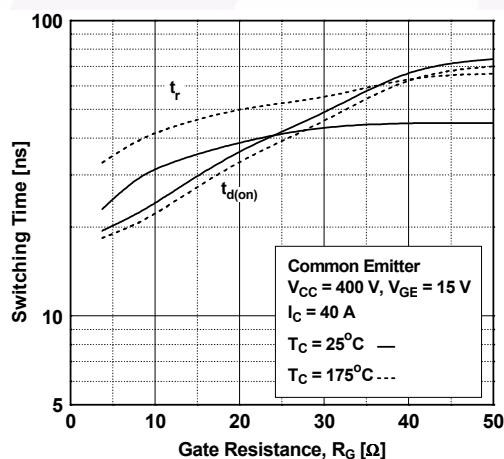


Figure 10. Turn-off Characteristics vs. Gate Resistance

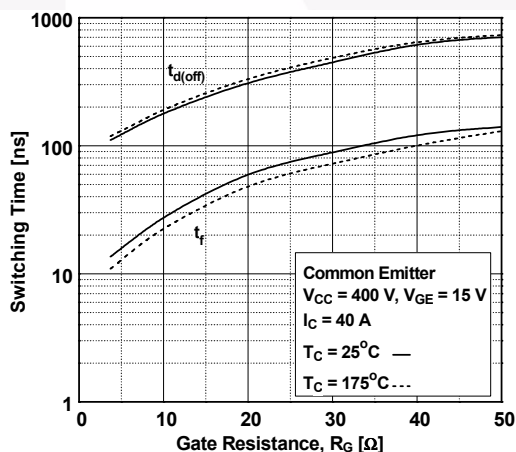


Figure 11. Switching Loss vs. Gate Resistance

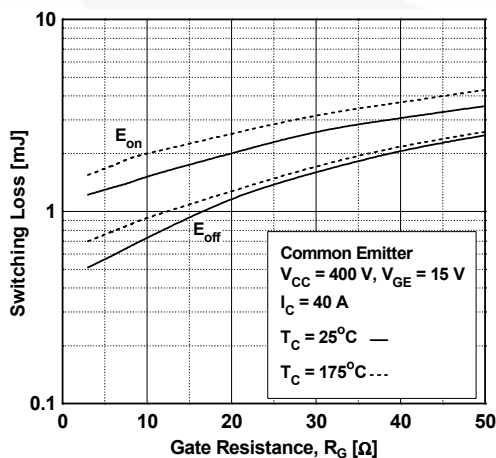
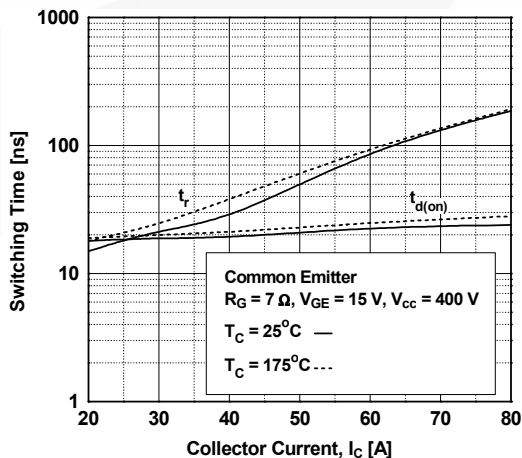
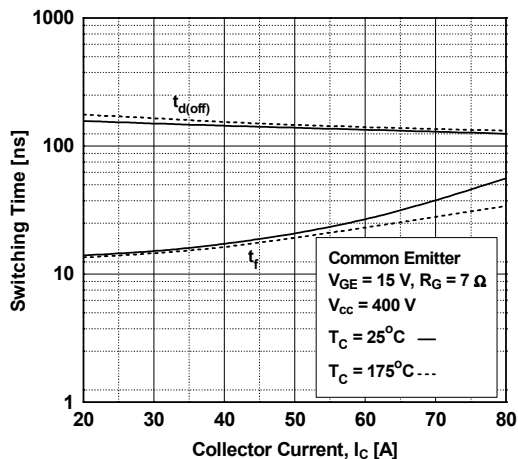


Figure 12. Turn-on Characteristics vs. Collector Current

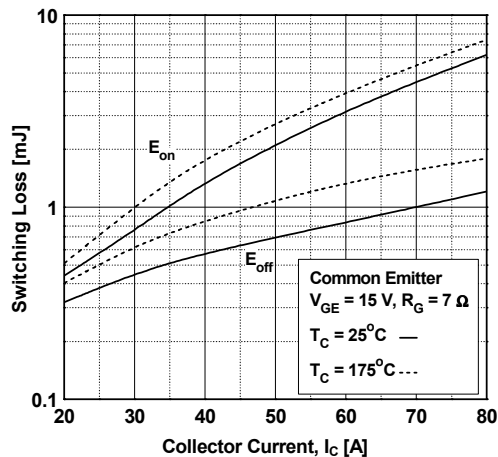


### Typical Performance Characteristics

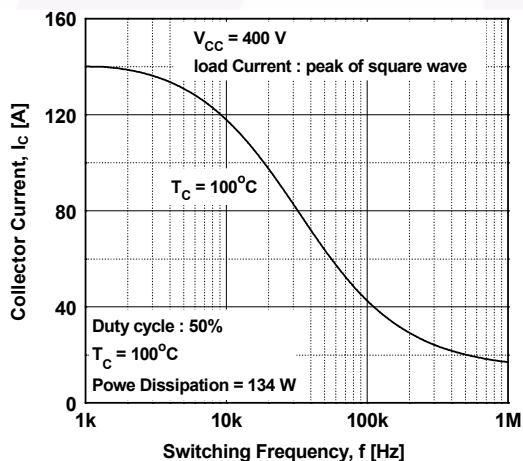
**Figure 13. Turn-off Characteristics vs. Collector Current**



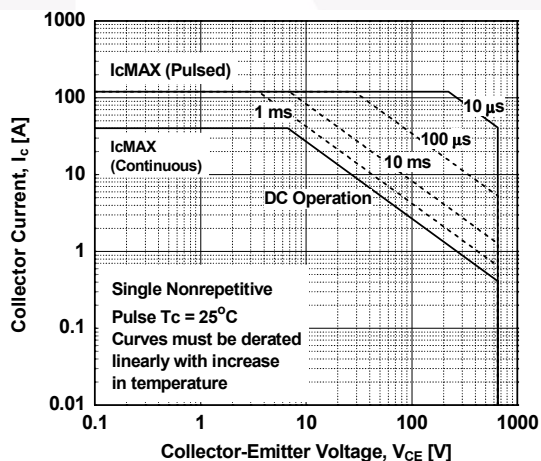
**Figure 14. Switching Loss vs. Collector Current**



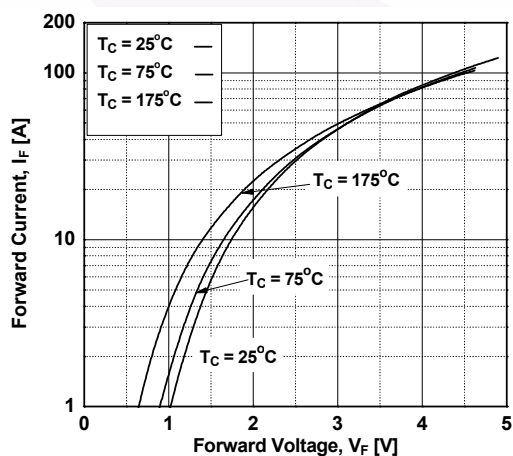
**Figure 15. Load Current vs. Frequency**



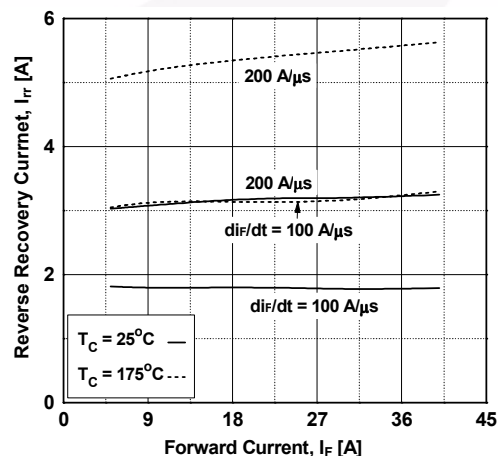
**Figure 16. SOA Characteristics**



**Figure 17. Forward Characteristics**



**Figure 18. Reverse Recovery Current**



## Typical Performance Characteristics

Figure 19. Reverse Recovery Time

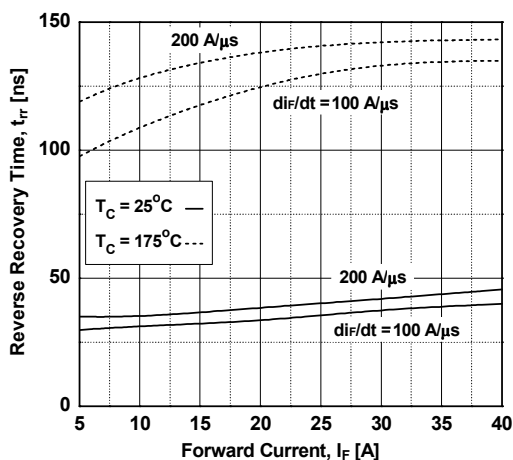


Figure 20. Stored Charge

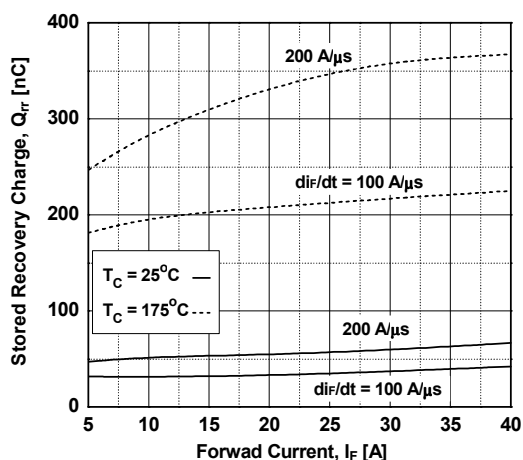


Figure 21. Transient Thermal Impedance of IGBT

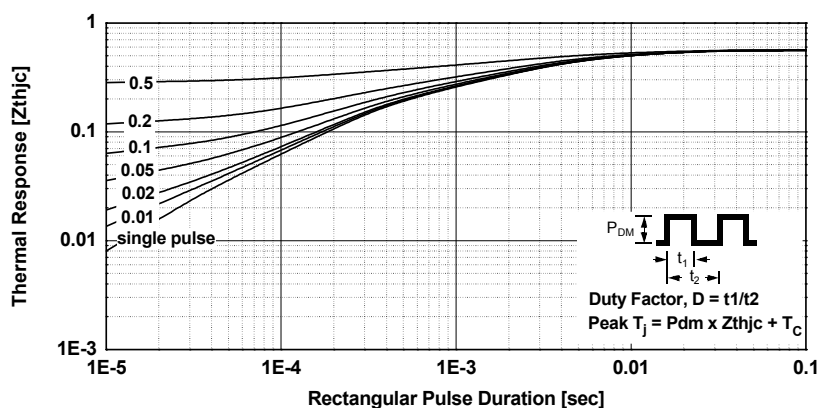
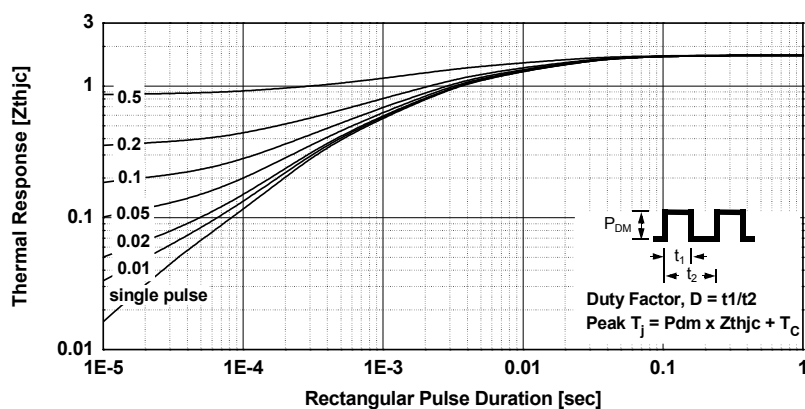
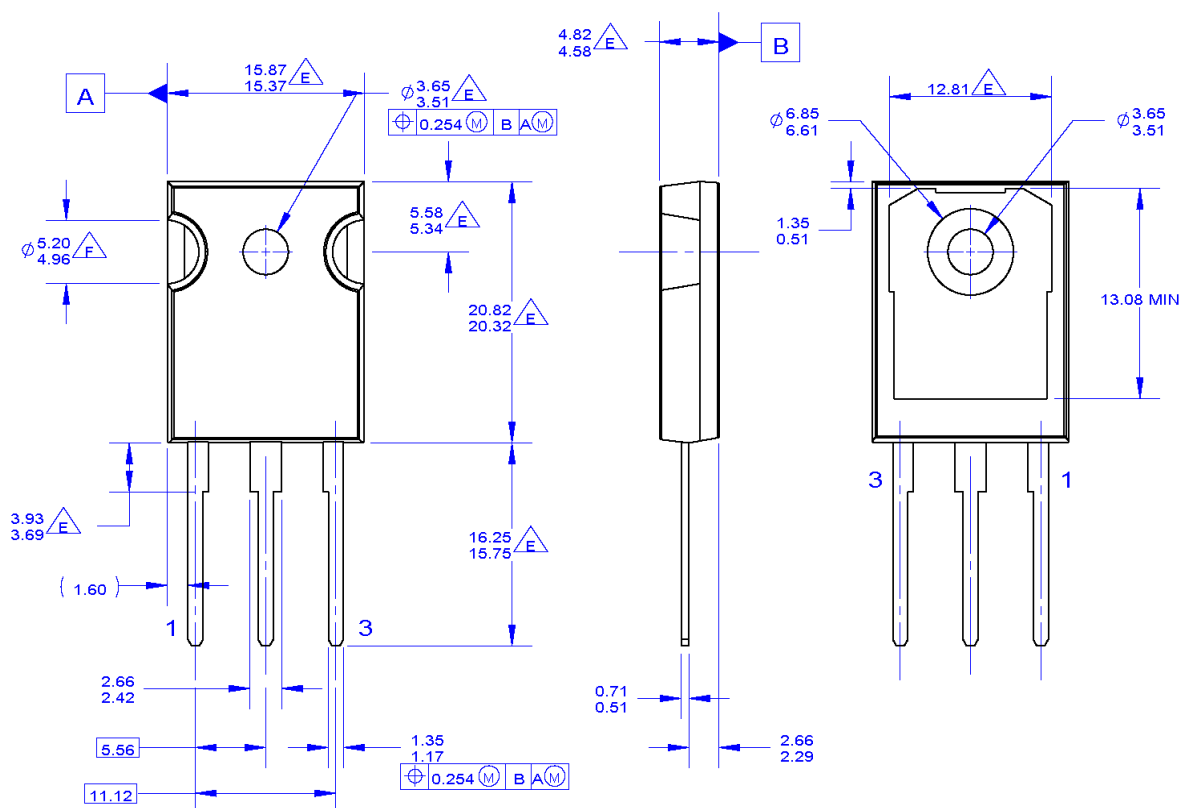


Figure 22. Transient Thermal Impedance of Diode





### Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. 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

- DOES NOT COMPLY JEDEC STANDARD VALUE
- NOTCH MAY BE SQUARE
- G. DRAWING FILENAME: MKT-TO247A03\_REV03

**Figure 23. TO-247, MOLDED, 3 LEAD, JEDEC VARIATION AB (Active)**

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Dimensions in Millimeters



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| AX-CAP®*   | FRFET®  | PowerXS™  | <b>SYSTEM GENERAL</b> ®*  |
| BitSiC™  | Global Power Resource <sup>SM</sup>             | Programmable Active Droop™  | TinyBoost®  |
| Build it Now™  | GreenBridge™                                    | QFET®   | TinyBuck®   |
| CorePLUS™  | Green FPS™                                      | QS™   | TinyCalc™   |
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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.
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