



# FGH40T65SPD\_F085

## 650V, 40A Field Stop Trench IGBT

### Features

- AEC-Q101 Qualified
- Low Saturation Voltage :  $V_{CE(sat)} = 1.85 \text{ V(Typ.) @ } I_C = 40 \text{ A}$
- 100% of the parts are dynamically tested (Note 1)
- Short Circuit Ruggedness  $> 5 \mu\text{s @ } 25 \text{ }^\circ\text{C}$
- Maximum Junction Temperature :  $T_J = 175 \text{ }^\circ\text{C}$
- Fast Switching
- Tight Parameter Distribution
- Positive Temperature Co-efficient for Easy Parallel Operating
- Copacked with soft, fast recovery diode
- RoHS Compliant

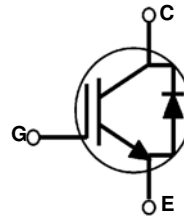
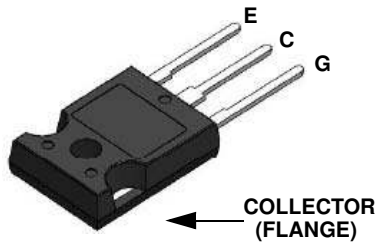


### General Description

Using the novel field stop 3rd generation IGBT technology, FGH40T65SPD\_F085 offers the optimum performance with both low conduction loss and switching loss for a high efficiency operation in various applications, while provides 50V higher blocking voltage and rugged high current switching reliability. Meanwhile, this part also offers and advantage of outstanding performance in parallel operation.

### Applications

- Onboard Charger
- AirCon Compressor
- PTC Heater
- Motor Drivers
- Other automotive power-train applications



### Absolute Maximum Ratings

Symbol	Description	Ratings	Units
$V_{CES}$	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 @ $T_C = 25 \text{ }^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100 \text{ }^\circ\text{C}$	40	A
$I_{CM}$	Pulsed Collector Current (Note 2)	120	A
$I_F$	Diode Forward Current @ $T_C = 25 \text{ }^\circ\text{C}$	40	A
	Diode Forward Current @ $T_C = 100 \text{ }^\circ\text{C}$	20	A
$I_{FM}$	Pulsed Diode Maximum Forward Current (Note 2)	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25 \text{ }^\circ\text{C}$	267	W
	Maximum Power Dissipation @ $T_C = 100 \text{ }^\circ\text{C}$	134	W
SCWT	Short Circuit Withstand Time @ $T_C = 25 \text{ }^\circ\text{C}$	5	$\mu\text{s}$
$T_J$	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:  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $I_C = 120 \text{ A}$ ,  $R_G = 20 \Omega$ , Inductive Load  
 2: Repetitive rating: pulse width limited by max. junction temperature

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case	-	0.56	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case	-	1.71	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^{\circ}\text{C}/\text{W}$

### Package Marking and Ordering Information

Device Marking	Device	Package	Pacing Type	Qty per Tube
FGH40T65SPD	FGH40T65SPD_F085	TO-247 G03	Tube	30ea

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>Off Characteristics</b>						
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{V}, I_C = 1\text{mA}$	650	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{V}, I_C = 1\text{mA}$	-	0.6	-	$\text{V}/^{\circ}\text{C}$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0\text{V}$	-	-	250	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{V}$	-	-	$\pm 400$	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 40\text{mA}, V_{CE} = V_{GE}$	4.0	5.5	7.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 40\text{A}, V_{GE} = 15\text{V}$	-	1.85	2.4	V
		$I_C = 40\text{A}, V_{GE} = 15\text{V}, T_C = 175^{\circ}\text{C}$	-	2.51	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	1518	-	pF
$C_{oes}$	Output Capacitance		-	91	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	15	-	pF
<b>Switching Characteristics</b>						
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 6\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_C = 25^{\circ}\text{C}$	-	18	-	ns
$T_r$	Rise Time		-	42	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	35	-	ns
$T_f$	Fall Time		-	10	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.16	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.27	-	mJ
$E_{ts}$	Total Switching Loss		-	1.43	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 6\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_C = 175^{\circ}\text{C}$	-	16	-	ns
$T_r$	Rise Time		-	40	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	37	-	ns
$T_f$	Fall Time		-	11	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.59	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.42	-	mJ
$E_{ts}$	Total Switching Loss		-	2.01	-	mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units
$Q_g$	Total Gate Charge	$V_{CE} = 400V, I_C = 40A,$ $V_{GE} = 15V$	-	36	-	nC
$Q_{ge}$	Gate to Emitter Charge		-	11	-	nC
$Q_{gc}$	Gate to Collector Charge		-	12	-	nC

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 20A$	$T_C = 25\text{ }^\circ\text{C}$	-	2.2	2.7	V
			$T_C = 175\text{ }^\circ\text{C}$	-	1.9	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20A,$ $di_F/dt = 200A/\mu s$	$T_C = 175\text{ }^\circ\text{C}$	-	51	-	$\mu J$
$T_{rr}$	Diode Reverse Recovery Time		$T_C = 25\text{ }^\circ\text{C}$	-	35	-	ns
			$T_C = 175\text{ }^\circ\text{C}$	-	214	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25\text{ }^\circ\text{C}$	-	58	-	$\mu C$
		$T_C = 175\text{ }^\circ\text{C}$	-	776	-		

## Typical Performance Characteristics

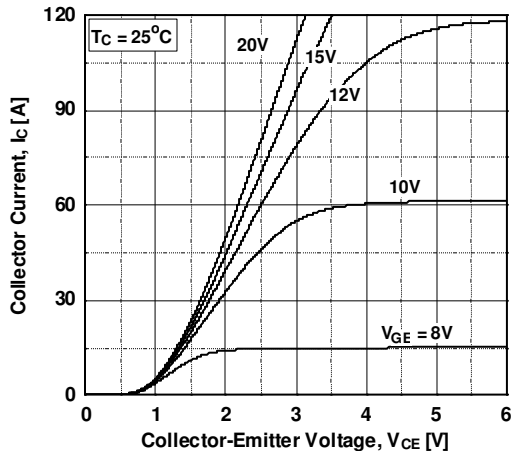


Figure 1. Typical Output Characteristics

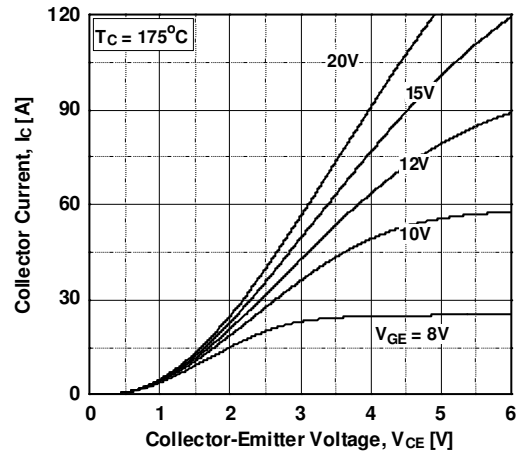


Figure 2. Typical Output Characteristics

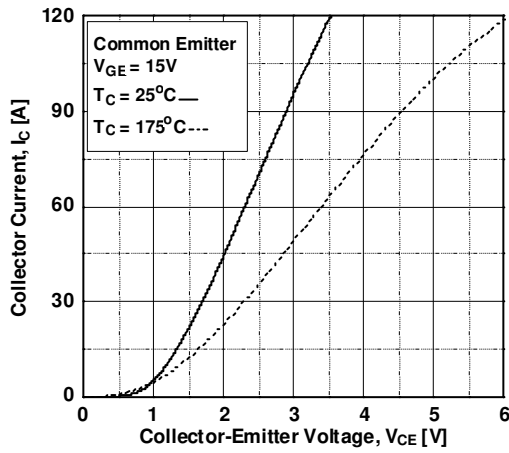


Figure 3. Typical Saturation Voltage Characteristics

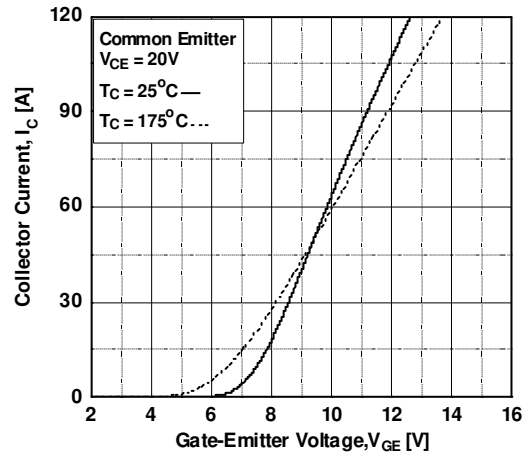


Figure 4. Transfer Characteristic

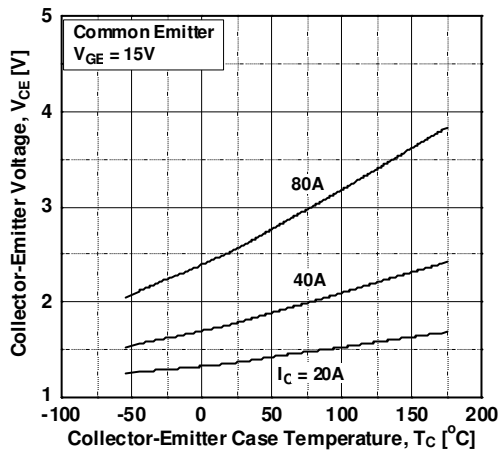


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

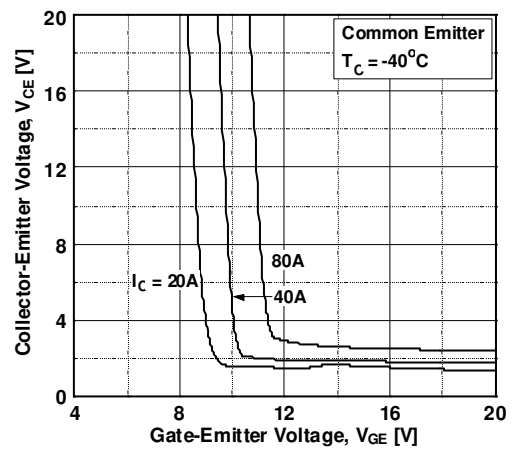


Figure 6. Saturation Voltage vs.  $V_{GE}$

### Typical Performance Characteristics

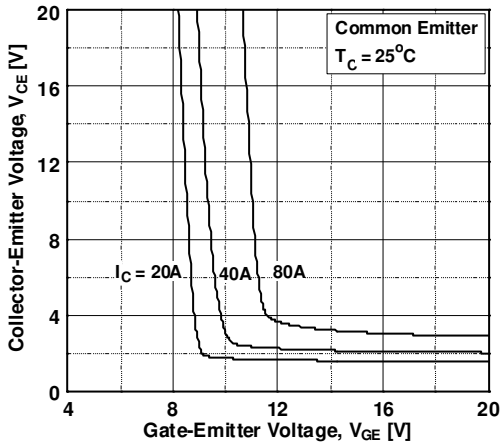


Figure 7. Saturation Voltage vs.  $V_{GE}$

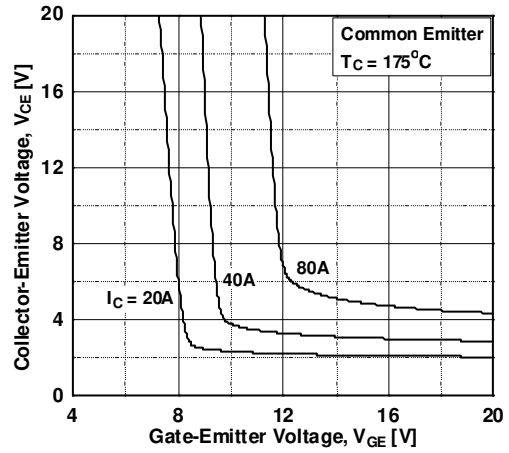


Figure 8. Saturation Voltage vs.  $V_{GE}$

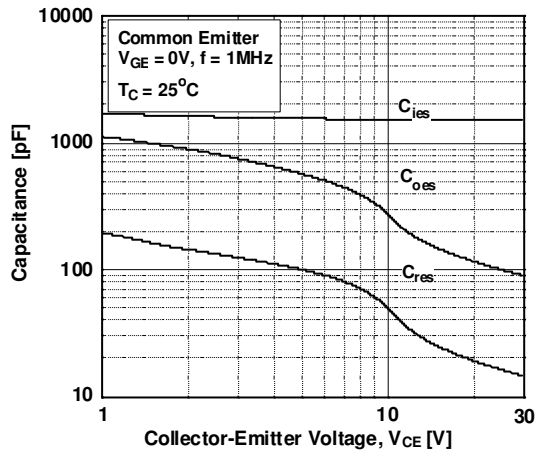


Figure 9. Capacitance Characteristics

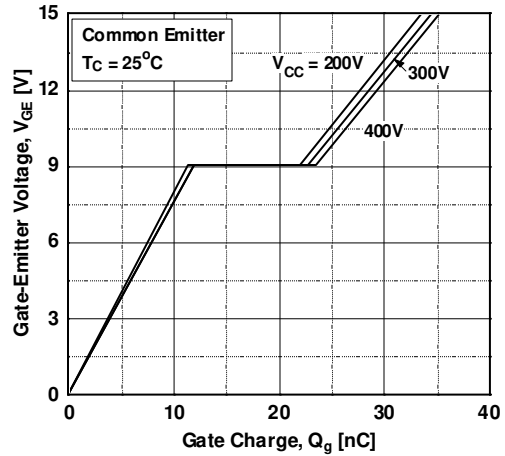


Figure 10. Gate charge Characteristics

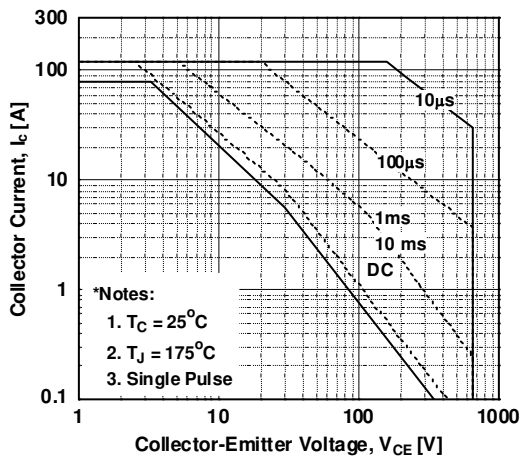


Figure 11. SOA Characteristics

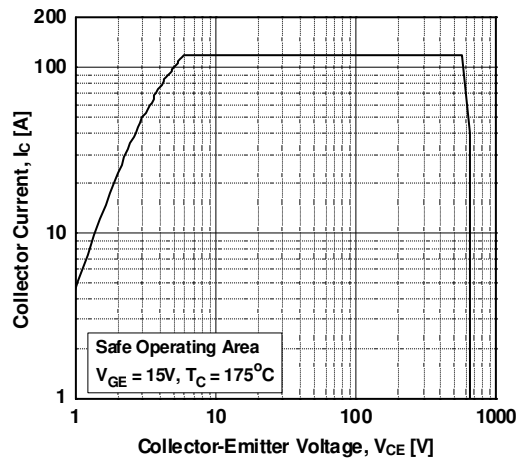


Figure 12. Turn off Switching SOA Characteristics

### Typical Performance Characteristics

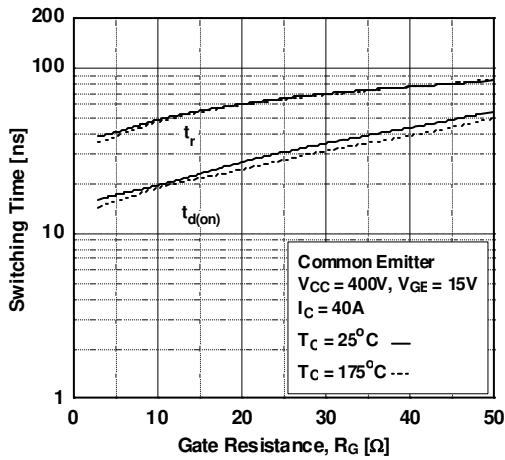


Figure 13. Turn-on Characteristics vs. Gate Resistance

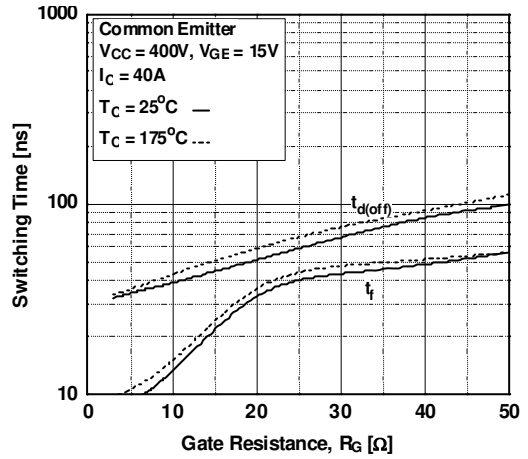


Figure 14. Turn-off Characteristics vs. Gate Resistance

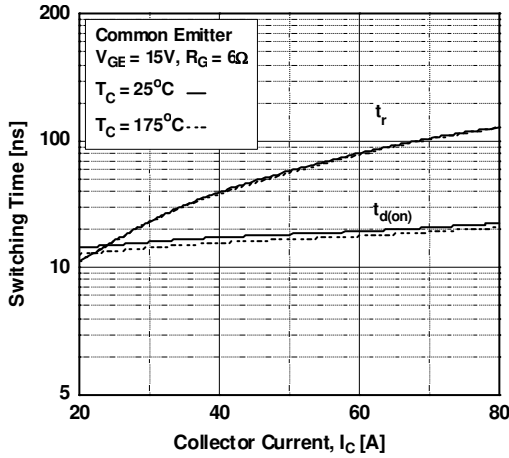


Figure 15. Turn-on Characteristics vs. Collector Current

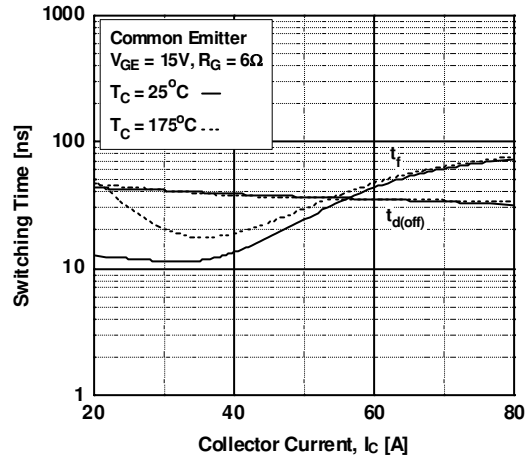


Figure 16. Turn-off Characteristics vs. Collector Current

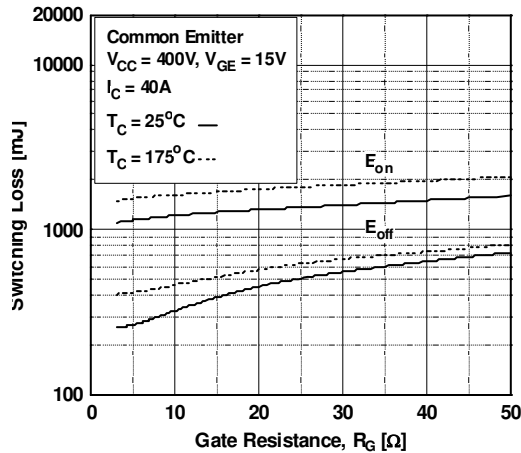


Figure 17. Switching Loss vs Gate Resistance

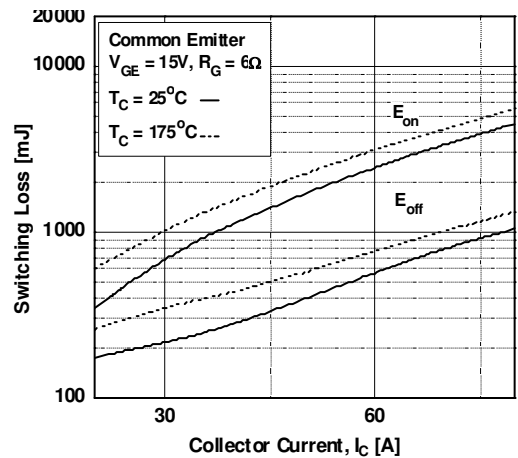


Figure 18. Switching Loss vs Collector Current

## Typical Performance Characteristics

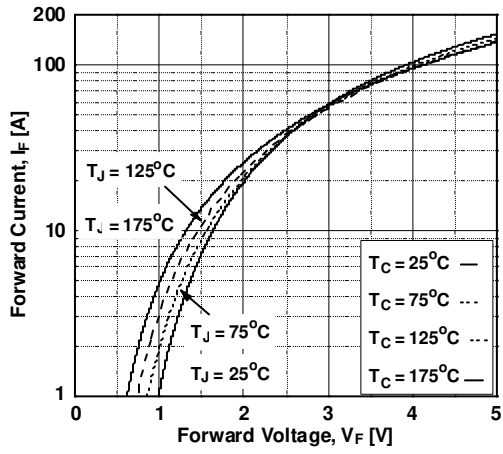


Figure 19. Forward Characteristics

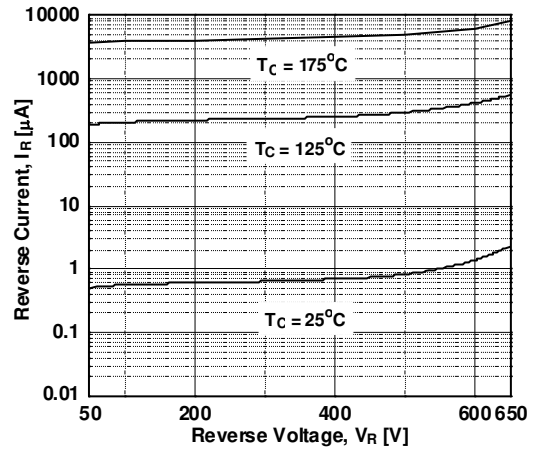


Figure 20. Reverse Current

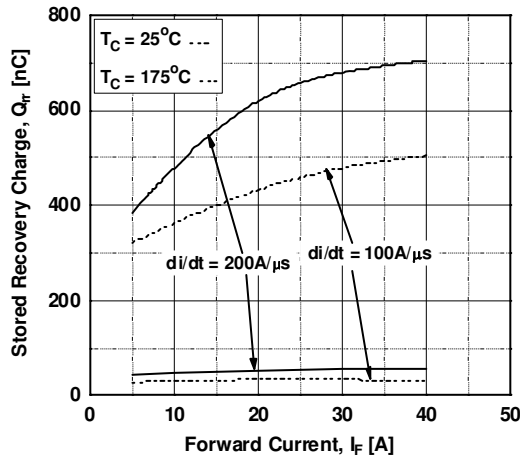


Figure 21. Stored Charge

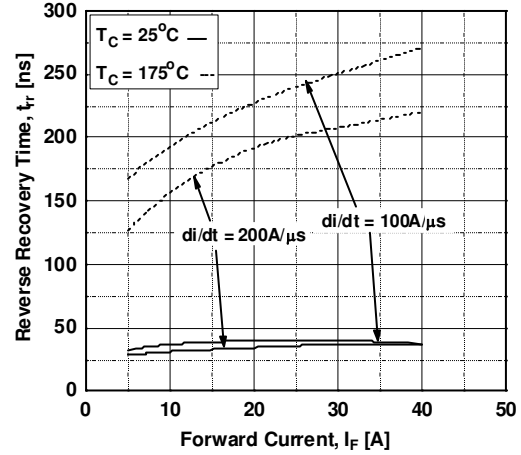


Figure 22. Reverse Recovery Time

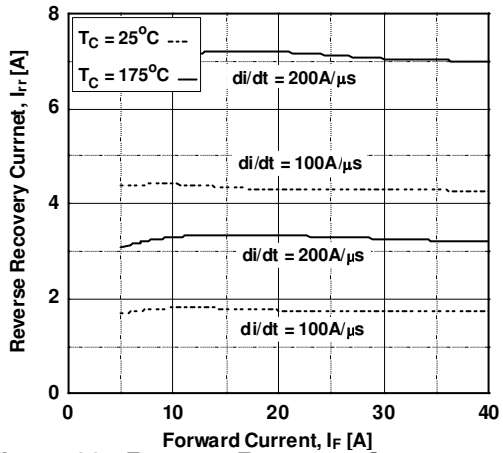


Figure 23. Reverse Recovery Current

Typical Performance Characteristics

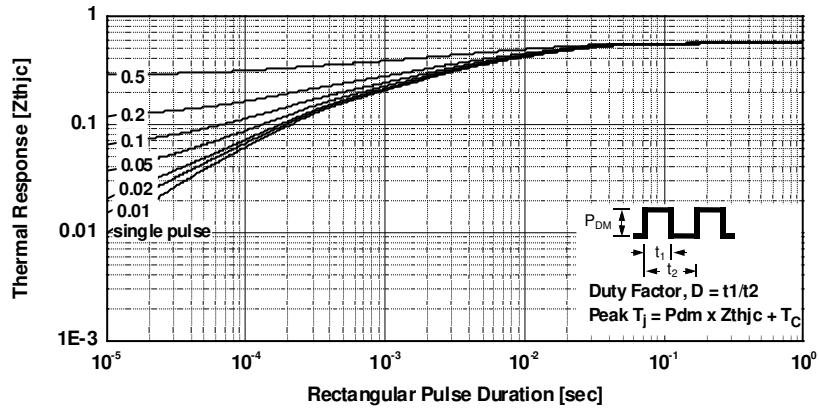


Figure 24. Transient Thermal Impedance of IGBT

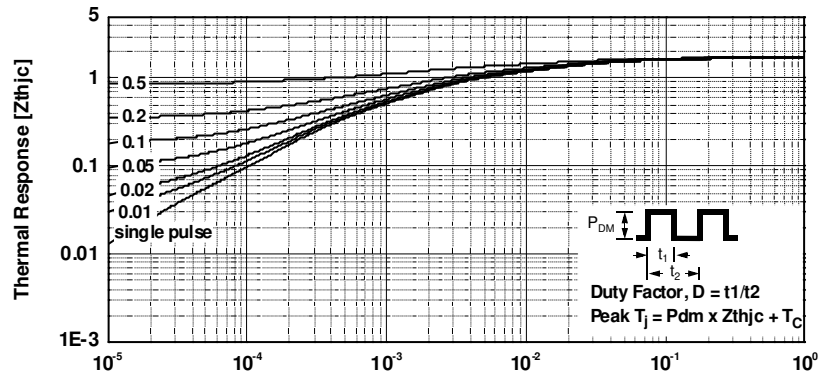
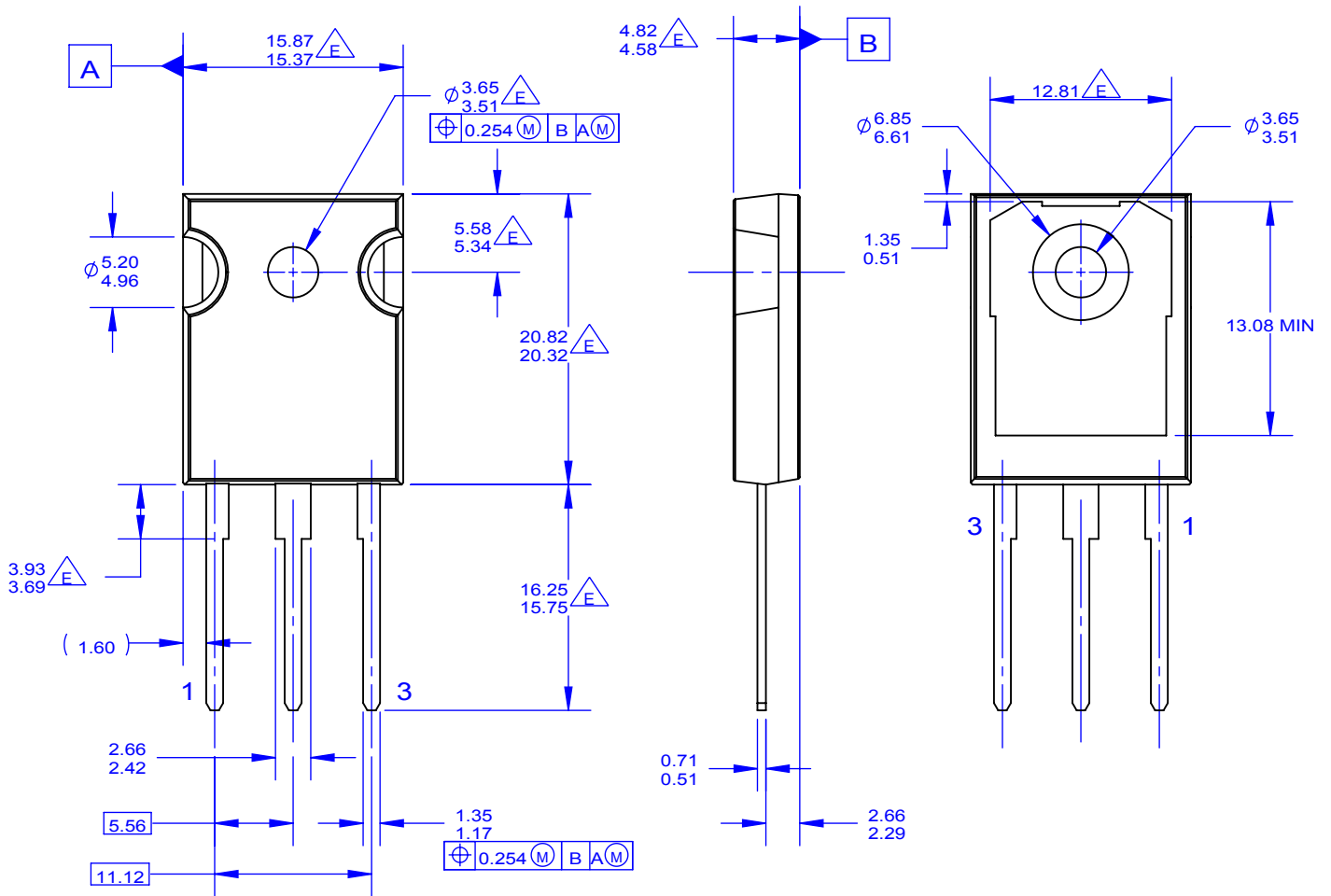


Figure 25. Transient Thermal Impedance of Diode





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  
 F. DRAWING FILENAME: MKT-TO247A03\_REV03



**TRADEMARKS**

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- |   |  |   |   |
|---|--|---|---|
| AccuPower™  | F-PFS™   | OPTOPLANAR®   |  |
| AttitudeEngine™   | FRFET®   |  | TinyBoost®  |
| Awinda®   | Global Power Resource <sup>SM</sup>            | PowerTrench®  | TinyBuck®   |
| AX-CAP®*  | GreenBridge™                                   | PowerXS™  | TinyCalc™   |
| BitSiC™   | Green FPS™                                     | Programmable Active Droop™  | TinyLogic®  |
| Build it Now™   | Green FPS™ e-Series™                           | QFET®   | TINYOPTO™   |
| CorePLUS™   | Gmax™  | QS™   | TinyPower™  |
| CorePOWER™  | GTO™   | Quiet Series™   | TinyPWM™  |
| CROSSVOL™   | IntelliMAX™                                    | RapidConfigure™   | TinyWire™   |
| CTL™  | ISOPLANAR™                                     |  | TranSiC™  |
| Current Transfer Logic™   | Making Small Speakers Sound Louder and Better™ | Saving our world, 1mW/W/kW at a time™   | TriFault Detect™  |
| DEUXPEED®   | MegaBuck™                                      | SignalWise™   | TRUECURRENT®*   |
| Dual Cool™  | MICROCOUPLER™                                  | SmartMax™   | μSerDes™  |
| EcoSPARK®   | MicroFET™                                      | SMART START™  |  |
| EfficientMax™   | MicroPak™                                      | Solutions for Your Success™   | UHC®  |
| ESBC™   | MicroPak2™                                     | SPM®  | Ultra FRFET™  |
|  | MillerDrive™                                   | STEALTH™  | UniFET™   |
| Fairchild®  | MotionMax™                                     | SuperFET®   | VCM™  |
| Fairchild Semiconductor®  | MotionGrid®                                    | SuperSOT™-3   | VisualMax™  |
| FACT Quiet Series™  | MTi®   | SuperSOT™-6   | VoltagePlus™  |
| FACT®   | MTX®   | SuperSOT™-8   | XS™   |
| FastvCore™  | MVN®   | SupreMOS®   | Xsens™  |
| FETBench™   | mWSaver®                                       | SyncFET™  | 仙童®   |
| FPS™  | OptoHiT™                                       | Sync-Lock™  |   |
|   | OPTOLOGIC®                                     |   |   |

\* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

**DISCLAIMER**

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. TO OBTAIN THE LATEST, MOST UP-TO-DATE DATASHEET AND PRODUCT INFORMATION, VISIT OUR WEBSITE AT [HTTP://WWW.FAIRCHILDSEMI.COM](http://www.fairchildsemi.com). FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

**AUTHORIZED USE**

Unless otherwise specified in this data sheet, this product is a standard commercial product and is not intended for use in applications that require extraordinary levels of quality and reliability. This product may not be used in the following applications, unless specifically approved in writing by a Fairchild officer: (1) automotive or other transportation, (2) military/aerospace, (3) any safety critical application – including life critical medical equipment – where the failure of the Fairchild product reasonably would be expected to result in personal injury, death or property damage. Customer's use of this product is subject to agreement of this Authorized Use policy. In the event of an unauthorized use of Fairchild's product, Fairchild accepts no liability in the event of product failure. In other respects, this product shall be subject to Fairchild's Worldwide Terms and Conditions of Sale, unless a separate agreement has been signed by both Parties.

**ANTI-COUNTERFEITING POLICY**

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, [www.fairchildsemi.com](http://www.fairchildsemi.com), under Terms of Use

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
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. I77