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FAIRCHILD SEMICONDUCTOR®

March 2014

# FGAF20N60SMD
## 600 V, 20 A Field Stop IGBT

### Features

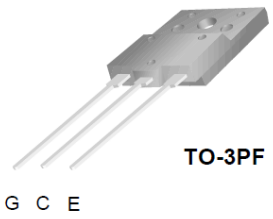
- Maximum Junction Temperature : $T_J$ = 175°C
- Positive Temperaure Co-efficient for easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.7 V(Typ.) @ $I_C$ = 20 A
- High Input Impedance
- Fast Swiching: $E_{OFF}$ = 7 uJ/A
- Tightened Parameter Distribution
- RoHS Compliant

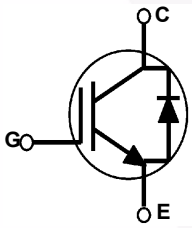
### General Description

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

### Applications

- Sewing Machine, CNC
- Home Appliances, Motor-Control




### Absolute Maximum Ratings

| Symbol | Description | | Ratings | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector to Emitter Voltage | | 600 | V |
| $V_{GES}$ | Gate to Emitter Voltage | | ± 20 | V |
| $I_C$ | Collector Current | @ $T_C$ = 25°C | 40 | A |
| | Collector Current | @ $T_C$ = 100°C | 20 | A |
| $I_{CM\ (1)}$ | Pulsed Collector Current | | 60 | A |
| $I_F$ | Diode Forward Current | @ $T_C$ = 25°C | 20 | A |
| | Diode Forward Current | @ $T_C$ = 100°C | 10 | A |
| $I_{FM\ (1)}$ | Pulsed Diode Maximum Forward Current | | 60 | A |
| $P_D$ | Maximum Power Dissipation | @ $T_C$ = 25°C | 75 | W |
| | Maximum Power Dissipation | @ $T_C$ = 100°C | 37.5 | W |
| $T_J$ | Operating Junction Temperature | | -55 to +175 | °C |
| $T_{stg}$ | Storage Temperature Range | | -55 to +175 | °C |
| $T_L$ | Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds | | 300 | °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 | - | 2.0 | °C/W |
| $R_{\theta JC}$(Diode) | Thermal Resistance, Junction to Case | - | 4.0 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | - | 40 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FGAF20N60SMD | FGAF20N60SMD | TO-3PF | - | - | 30 |

## Electrical Characteristics of the IGBT $T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{CES}$ | Collector to Emitter Breakdown Voltage | $V_{GE}$ = 0V, $I_C$ = 250μA | 600 | - | - | V |
| $\frac{\Delta BV_{CES}}{\Delta T_J}$ | Temperature Coefficient of Breakdown Voltage | $V_{GE}$ = 0V, $I_C$ = 250μA | - | 0.62 | - | V/°C |
| $I_{CES}$ | Collector Cut-Off Current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | - | - | 250 | μA |
| $I_{GES}$ | G-E Leakage Current | $V_{GE}$ = $V_{GES}$, $V_{CE}$ = 0V | - | - | ±400 | nA |
| **On Characteristics** | | | | | | |
| $V_{GE(th)}$ | G-E Threshold Voltage | $I_C$ = 250μA, $V_{CE}$ = $V_{GE}$ | 3.5 | 4.7 | 6.0 | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 20A, $V_{GE}$ = 15V | - | 1.7 | 2.5 | V |
| | | $I_C$ = 20A, $V_{GE}$ = 15V, $T_C$ = 175°C | - | 1.9 | - | V |
| **Dynamic Characteristics** | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{CE}$ = 30V, $V_{GE}$ = 0V, f = 1MHz | - | 925 | - | pF |
| $C_{oes}$ | Output Capacitance | | - | 89 | - | pF |
| $C_{res}$ | Reverse Transfer Capacitance | | - | 30 | - | pF |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$ = 400V, $I_C$ = 20A, $R_G$ = 10Ω, $V_{GE}$ = 15V, Inductive Load, $T_C$ = 25°C | - | 12 | - | ns |
| $t_r$ | Rise Time | | - | 22 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 91 | - | ns |
| $t_f$ | Fall Time | | - | 21 | 27 | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 452 | - | uJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 141 | 187 | uJ |
| $E_{ts}$ | Total Switching Loss | | - | 593 | - | uJ |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$ = 400V, $I_C$ = 20A, $R_G$ = 10Ω, $V_{GE}$ = 15V, Inductive Load, $T_C$ = 175°C | - | 12 | - | ns |
| $t_r$ | Rise Time | | - | 19 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 93 | - | ns |
| $t_f$ | Fall Time | | - | 16 | - | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 667 | - | uJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 317 | - | uJ |
| $E_{ts}$ | Total Switching Loss | | - | 984 | - | uJ |

## Electrical Characteristics of the IGBT (Continued)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge | $V_{CE}$ = 400V, $I_C$ = 20A, $V_{GE}$ = 15V | - | 64 | - | nC |
| $Q_{ge}$ | Gate to Emitter Charge | | - | 6.2 | - | nC |
| $Q_{gc}$ | Gate to Collector Charge | | - | 32 | - | nC |

## Electrical Characteristics of the Diode $T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{FM}$ | Diode Forward Voltage | $I_F$ = 10A | $T_C$ = 25°C | - | 2.3 | - | V |
| | | | $T_C$ = 175°C | - | 1.67 | - | |
| $E_{rec}$ | Reverse Recovery Energy | $I_F$ =10A, $dI_F/dt$ = 200A/µs | $T_C$ = 175°C | - | 13.8 | - | uJ |
| $t_{rr}$ | Diode Reverse Recovery Time | | $T_C$ = 25°C | - | 26.7 | - | ns |
| | | | $T_C$ = 175°C | - | 88.2 | - | |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | $T_C$ = 25°C | - | 42 | - | nC |
| | | | $T_C$ = 175°C | - | 245 | - | |

## Typical Performance Characteristics

**Figure 1. Typical Output Characteristics**

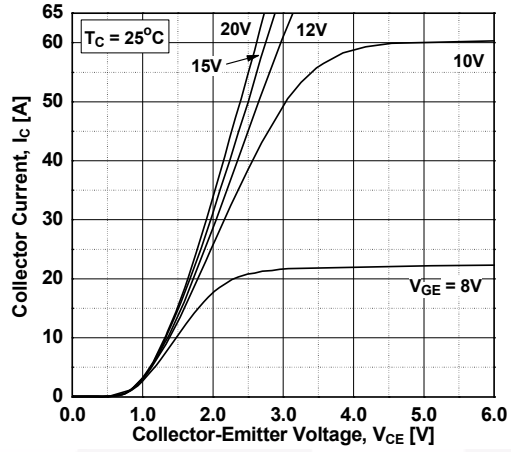



**Figure 2. Typical Output Characteristics**

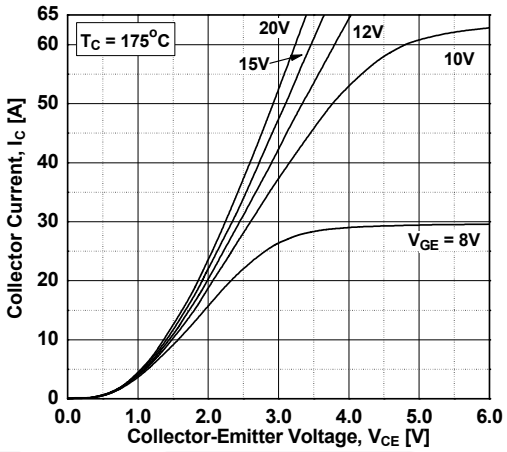



**Figure 3. Typical Saturation Voltage Characteristics**

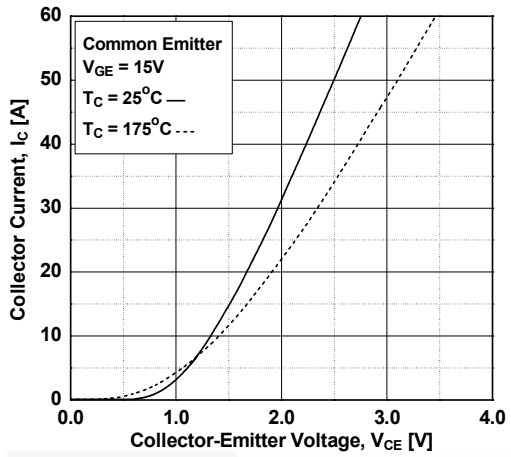



**Figure 4. Transfer Characteristics**

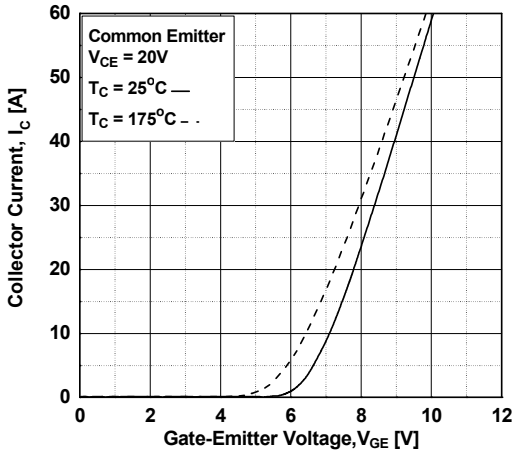



**Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level**

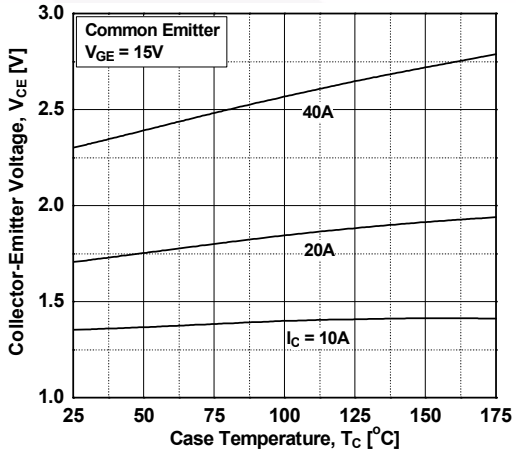
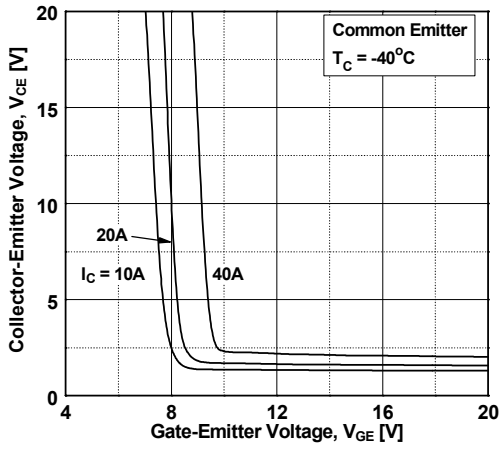



**Figure 6. Saturation Voltage vs. $V_{GE}$**



## Typical Performance Characteristics

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

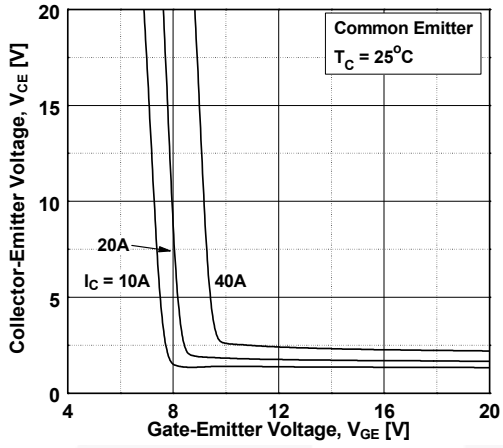



**Figure 8. Saturation Voltage vs. $V_{GE}$**

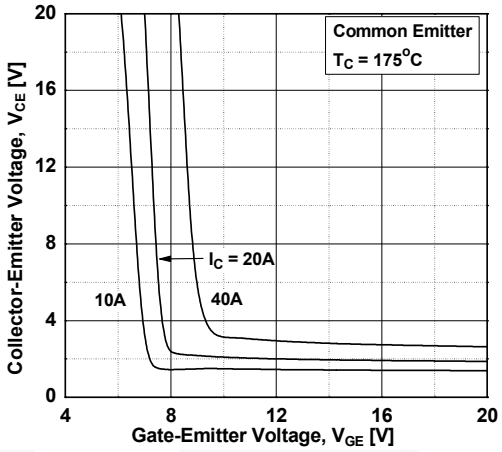



**Figure 9. Capacitance Characteristics**

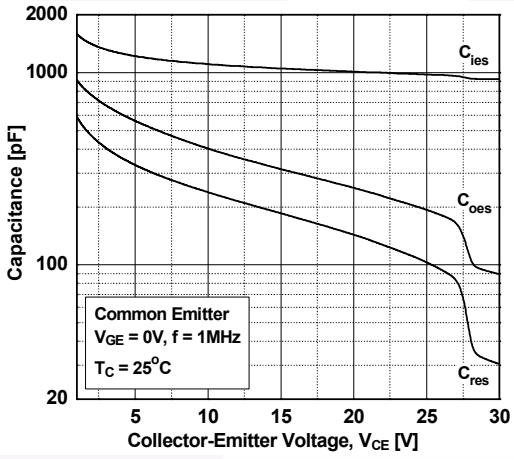



**Figure 10. Gate charge Characteristics**

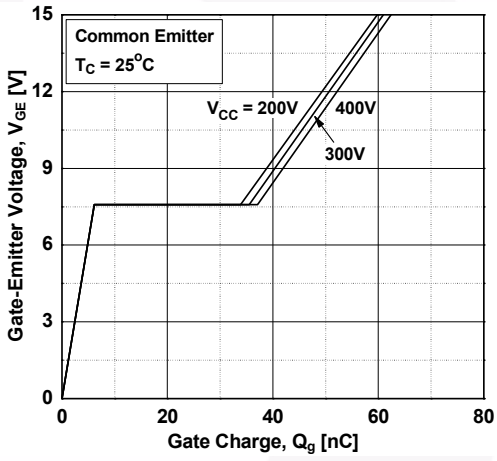



**Figure 11. SOA Characteristics**

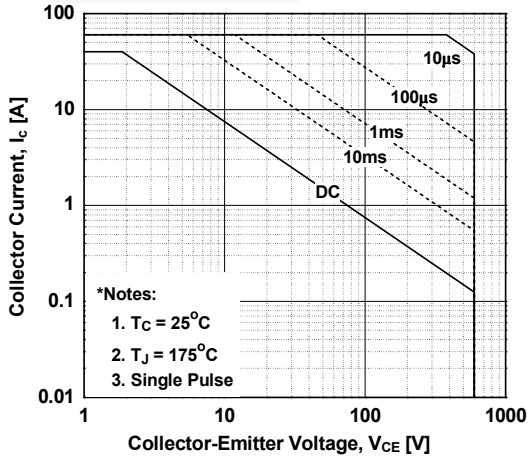
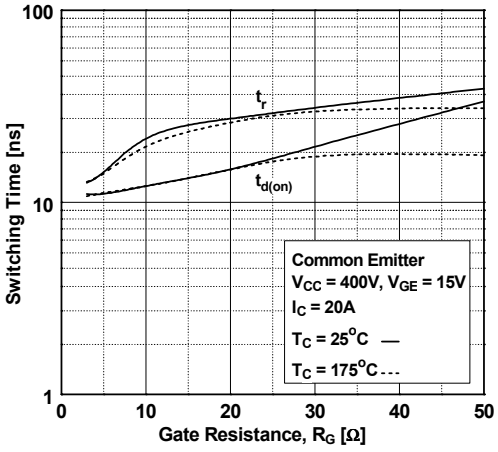



**Figure 12. Turn-on Characteristics vs. Gate Resistance**



## Typical Performance Characteristics

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

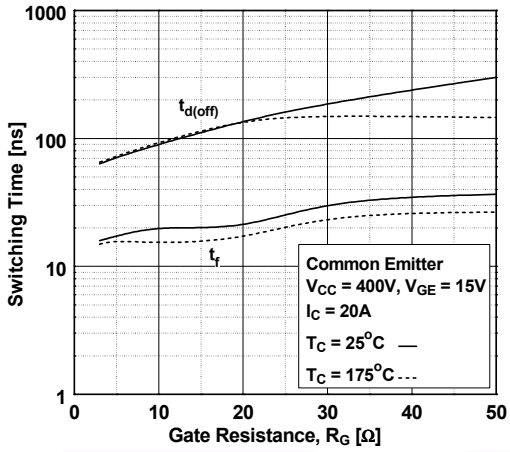



**Figure 14. Turn-on Characteristics vs. Collector Current**

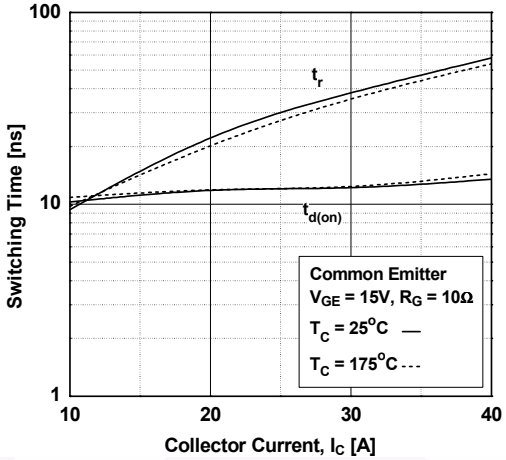



**Figure 15. Turn-off Characteristics vs. Collector Current**

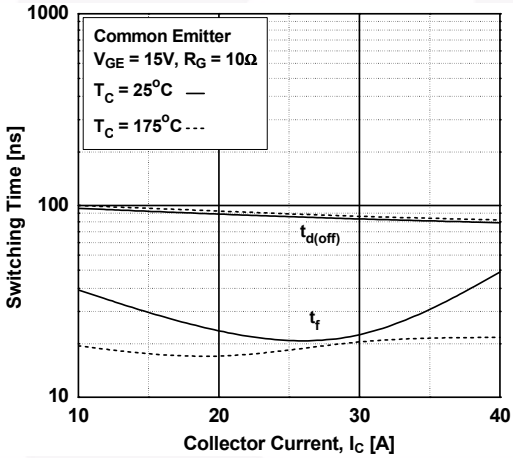



**Figure 16. Switching Loss vs. Gate Resistance**

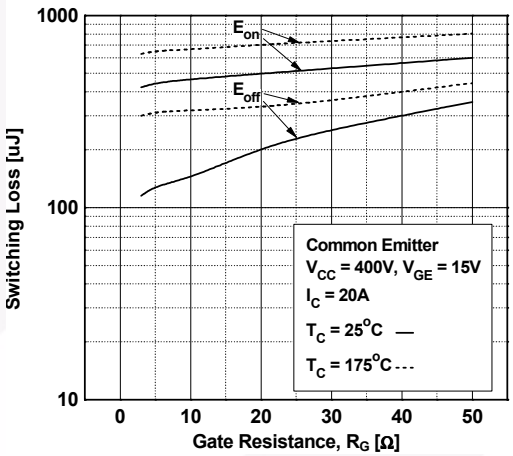



**Figure 17. Switching Loss vs. Collector Current**

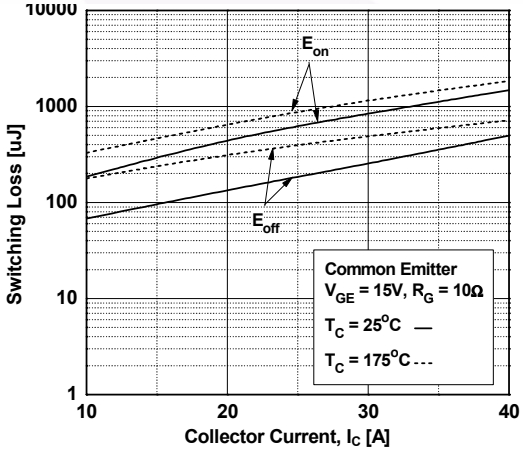
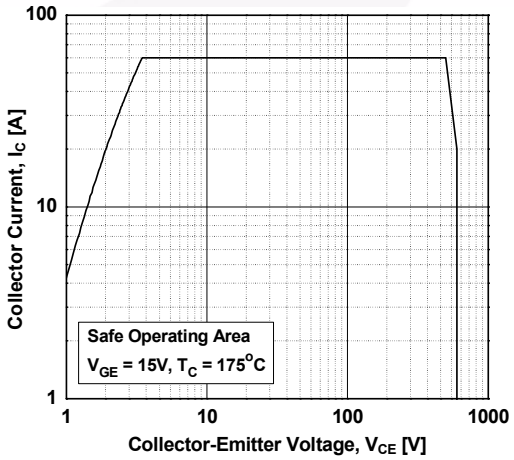
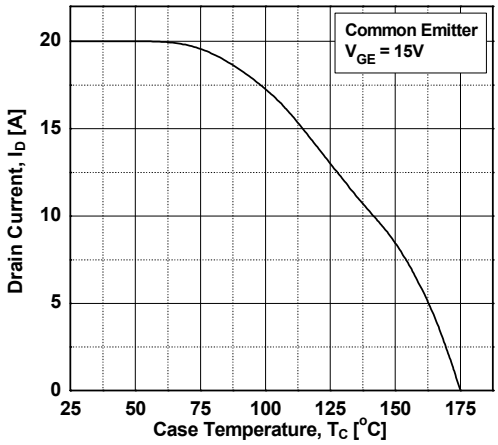



**Figure 18. Turn off Switching SOA Characteristics**

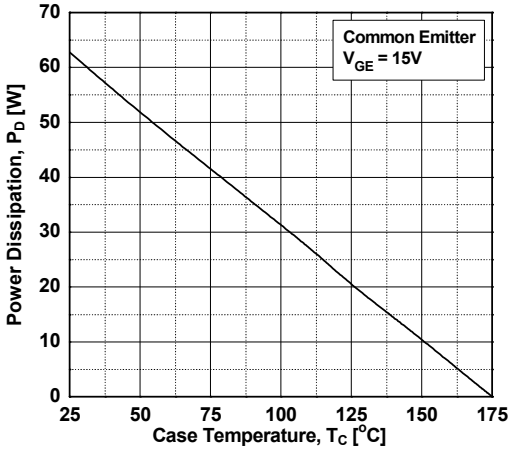


## Typical Performance Characteristics

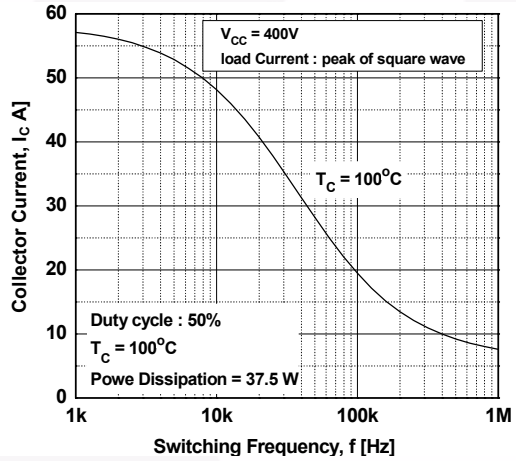
### Figure 19. Current Derating



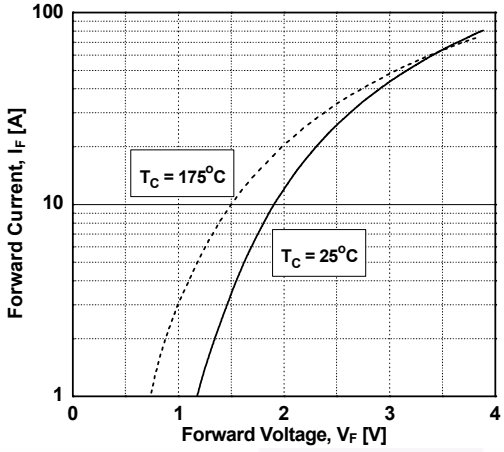

### Figure 20. Power Dissipation



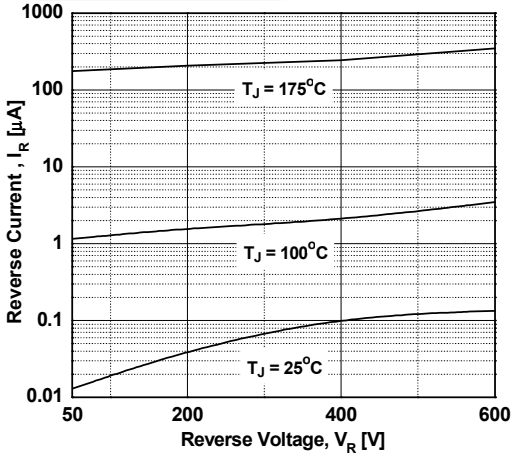

### Figure 21. Load Current Vs. Frequency



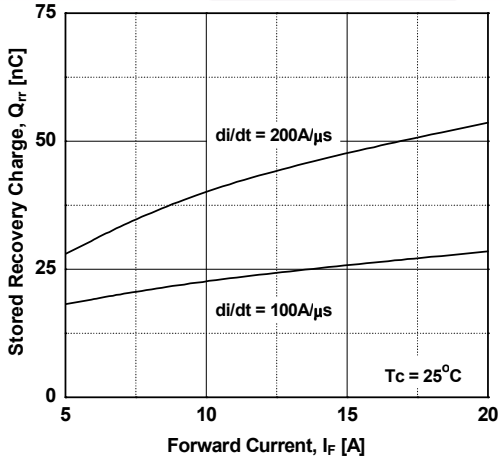

### Figure 22. Forward Characteristics




### Figure 23. Reverse Current




### Figure 24. Stored Charge



## Typical Performance Characteristics

**Figure 25. Reverse Recovery Time**

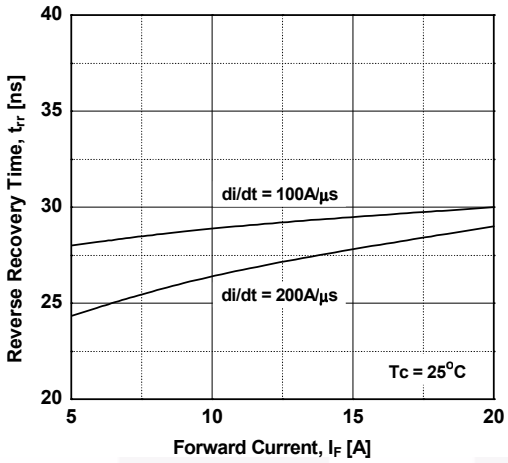



**Figure 26.Transient Thermal Impedance of IGBT**

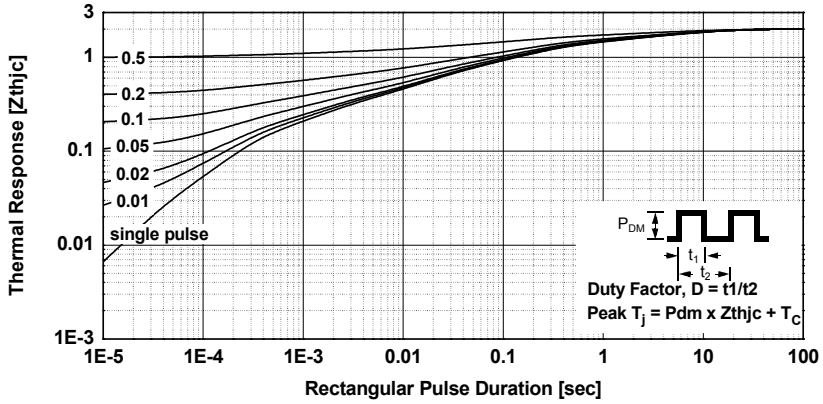
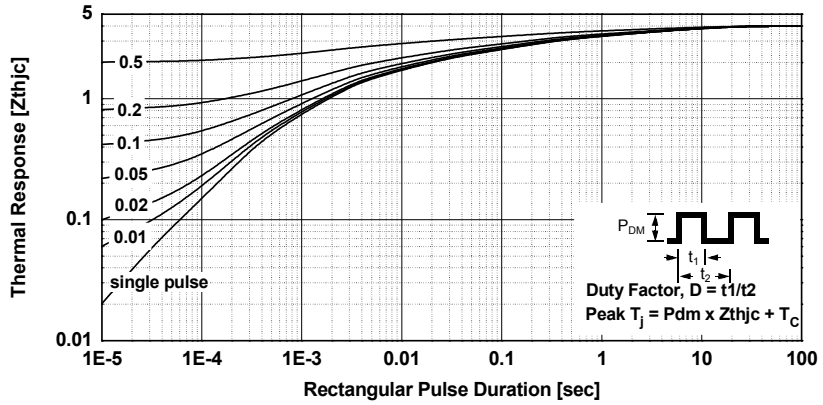



**Figure 27.Transient Thermal Impedance of Diode**



## Mechanical Dimensions

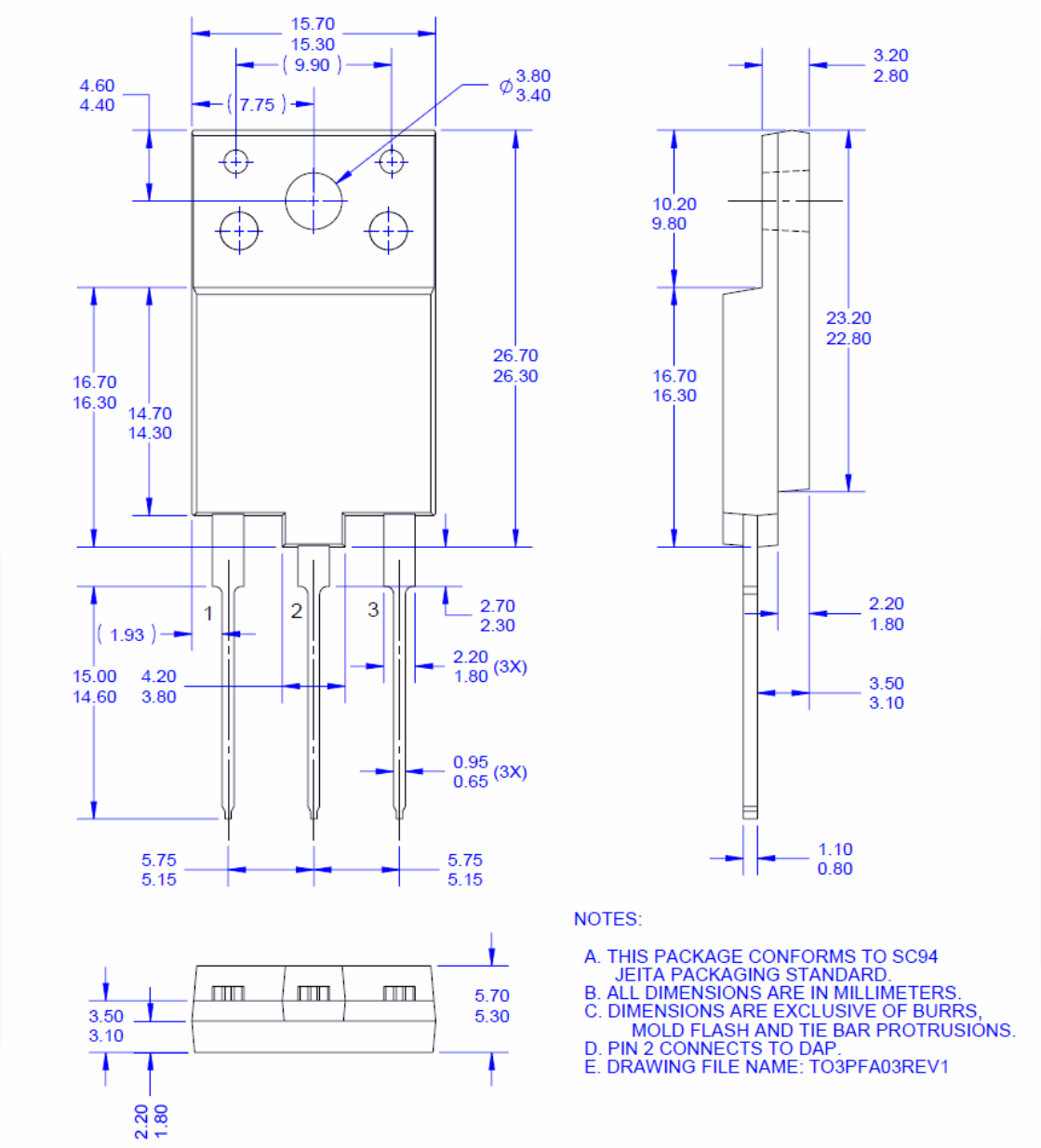



**Figure 28. TO3PF,MOLDED,3LD,FULLPACK (AG)**

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*http://www.fairchildsemi.com/package/packageDetails.html?id=PN_TO3PF-003*

Dimensions in Millimeters

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Saving our world, 1mW/W/kW at a time™
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SmartMax™
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SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
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TinyBoost®
TinyBuck®
TinyCalc™
TinyLogic®
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TinyPower™
TinyPWM™
TinyWire™
TranSiC™
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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Counterfeiting of semiconductor parts is a growing problem in the industry. All manufactures 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 application, 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 handing 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 and 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. |
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