# ON Semiconductor

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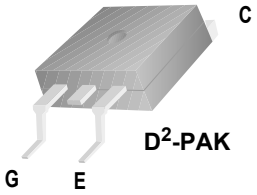
ON Semiconductor®

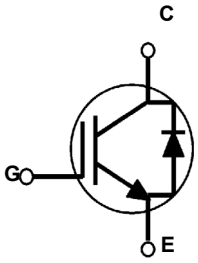
# FGB20N60SFD-F085
## 600V, 20A Field Stop IGBT

### Features
- High current capability
- Low saturation voltage: $V_{CE(sat)}$ = 2.2V @ $I_C$ = 20A
- High input impedance
- Fast switching
- Qualified to Automotive Requirements of AEC-Q101
- RoHS complaint

### Applications
- Inverters, SMPS, PFC, UPS
- Automotive Chargers, Converters, High Voltage Auxiliaries

### General Description
Using novel field-stop IGBT technology, ON Semiconductor's new series of field-stop IGBTs offers the optimum performance for automotive chargers, inverters, and other applications where low conduction and switching losses are essential.




### Absolute Maximum Ratings

| Symbol | Description | | Ratings | Units |
|---|---|---|---|---|
| $V_{CES}$ | 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 | @ $T_C$ = 25°C | 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 | 208 | W |
| | Maximum Power Dissipation | @ $T_C$ = 100°C | 83 | W |
| $T_J$ | Operating Junction Temperature | | -55 to +150 | °C |
| $T_{stg}$ | Storage Temperature Range | | -55 to +150 | °C |
| $T_L$ | Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds | | 300 | °C |

### Thermal Characteristics

| Symbol | Parameter | Ratings | Units |
|---|---|---|---|
| $R_{\theta JC}$(IGBT) (2) | Thermal Resistance, Junction to Case | 0.6 | °C/W |
| $R_{\theta JC}$(Diode) | Thermal Resistance, Junction to Case | 2.6 | °C/W |

| Symbol | Parameter | Typ. | Units |
|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (PCB Mount)(2) | 75 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Packaging Type | Qty per Tube | Max Qty per Box |
|---|---|---|---|---|---|
| FGB20N60SFD | FGB20N60SFD-F085 | TO-263 | Tube | 50ea | - |

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

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **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 | - | 0.79 | - | V/°C |
| $I_{CES}$ | Collector Cut-Off Current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | - | - | 250 | μA |
| | | ICES at 80%*BVCES, 150°C | - | - | 250 | |
| $I_{GES}$ | 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, $V_{CE}$ = $V_{GE}$ | 4.0 | 4.8 | 6.5 | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 20A, $V_{GE}$ = 15V | - | 2.2 | 2.85 | V |
| | | $I_C$ = 20A, $V_{GE}$ = 15V, $T_C$ = 125°C | - | 2.4 | - | V |
| **Dynamic Characteristics** | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{CE}$ = 30V, $V_{GE}$ = 0V, f = 1MHz | - | 940 | 1250 | pF |
| $C_{oes}$ | Output Capacitance | | - | 110 | 146 | pF |
| $C_{res}$ | Reverse Transfer Capacitance | | - | 40 | 53 | 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 | - | 10 | 13 | ns |
| $t_r$ | Rise Time | | - | 16 | 21 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 90 | 120 | ns |
| $t_f$ | Fall Time | | - | 24 | 36 | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 0.31 | 0.41 | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 0.13 | 0.21 | mJ |
| $E_{ts}$ | Total Switching Loss | | - | 0.44 | 0.59 | mJ |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$ = 400V, $I_C$ = 20A, $R_G$ = 10Ω, $V_{GE}$ = 15V, Inductive Load, $T_C$ = 125°C | - | 12 | 16 | ns |
| $t_r$ | Rise Time | | - | 16 | 21 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 95 | 126 | ns |
| $t_f$ | Fall Time | | - | 28 | 43 | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 0.45 | 0.60 | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 0.21 | 0.38 | mJ |
| $E_{ts}$ | Total Switching Loss | | - | 0.66 | 0.88 | mJ |
| $Q_g$ | Total Gate Charge | $V_{CE}$ = 400V, $I_C$ = 20A, $V_{GE}$ = 15V | - | 63 | 95 | nC |
| $Q_{ge}$ | Gate to Emitter Charge | | - | 7 | 11 | nC |
| $Q_{gc}$ | Gate to Collector Charge | | - | 32 | 48 | nC |

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

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_{FM}$ | Diode Forward Voltage | $I_F$ = 10A | $T_C$ = 25°C | - | 1.9 | 2.5 | V |
| | | | $T_C$ = 125°C | - | 1.7 | - | |
| $t_{rr}$ | Diode Reverse Recovery Time | $I_{ES}$ = 10A, $dI_{ES}/dt$ = 200A/μs | $T_C$ = 25°C | - | 111 | - | ns |
| | | | $T_C$ = 125°C | - | 204 | - | |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | $T_C$ = 25°C | - | 174 | 244 | nC |
| | | | $T_C$ = 125°C | - | 463 | - | |

**Notes:**

1: Repetitive rating: Pulse width limited by max. junction temperature

2:Rthjc for D2-PAK: according to Mil standard 883-1012 test method.

Rthja for D2-PAK: according to JESD51-2, test method environmental condition and JESD51-3,low effective thermal conductivity test board for leaded surface mount package. thermal measurements. JESD51-2: Integrated Circuits Thermal Test Method Environmental Conditions - Natural Convection (Still Air).

## Typical Performance Characteristics

**Figure 1. Typical Output Characteristics**

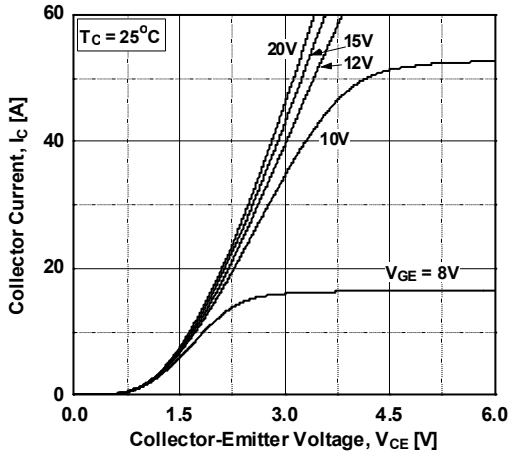



**Figure 2. Typical Output Characteristics**

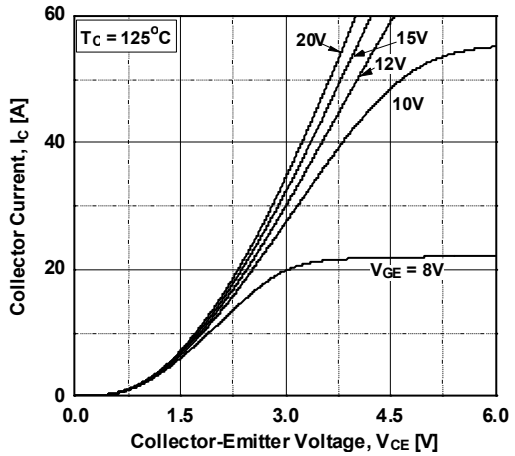



**Figure 3. Typical Saturation Voltage Characteristics**

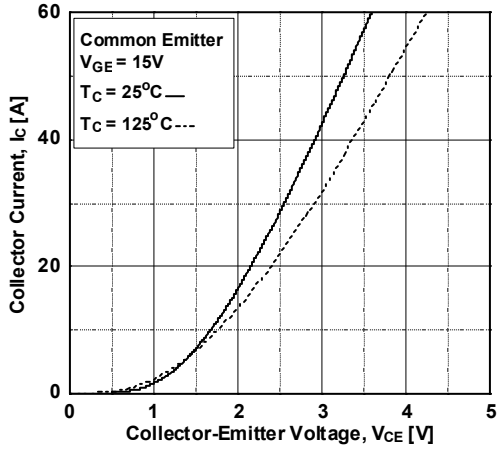



**Figure 4. Transfer Characteristics**

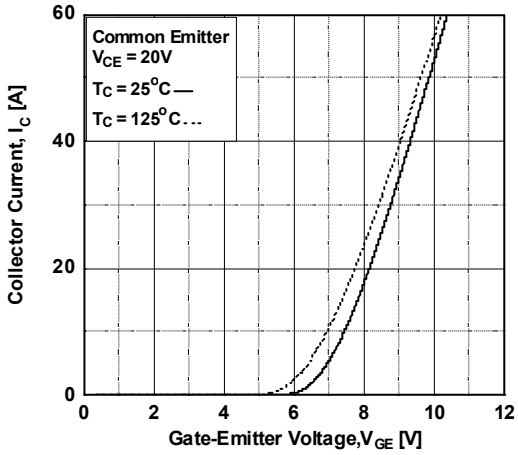



**Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level**

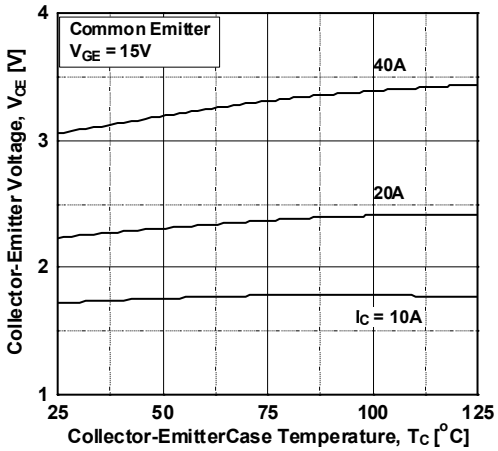
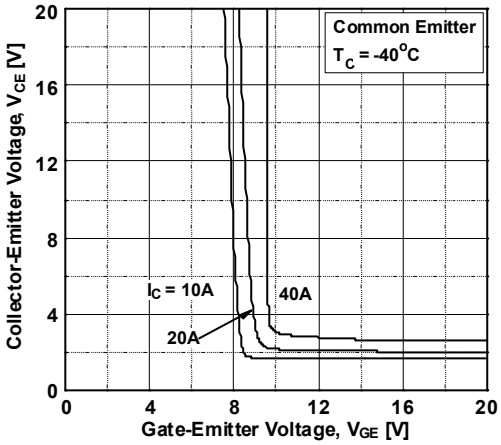



**Figure 6. Saturation Voltage vs. $V_{GE}$**



## Typical Performance Characteristics

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

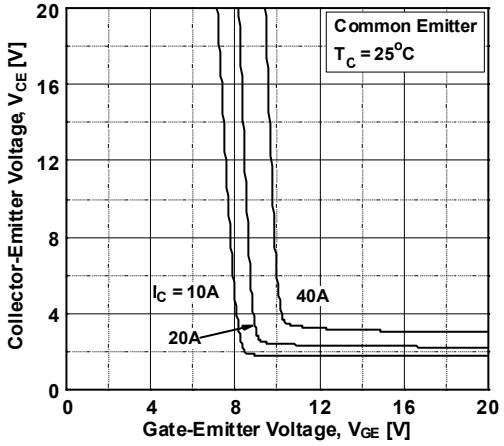



**Figure 8. Saturation Voltage vs. $V_{GE}$**

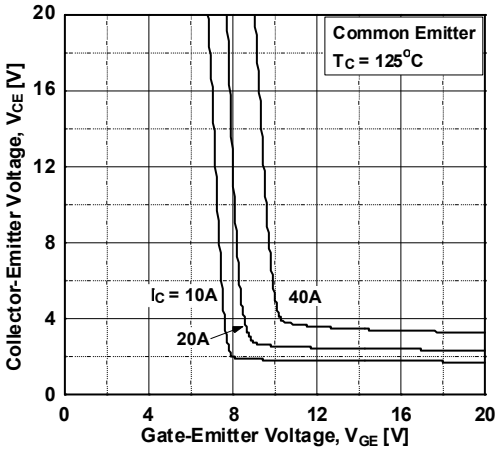



**Figure 9. Capacitance Characteristics**

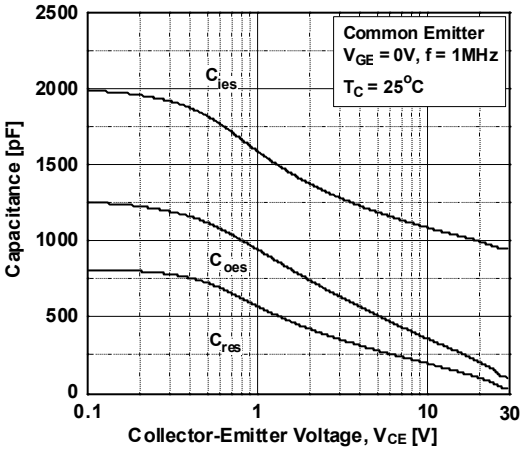



**Figure 10. Gate charge Characteristics**

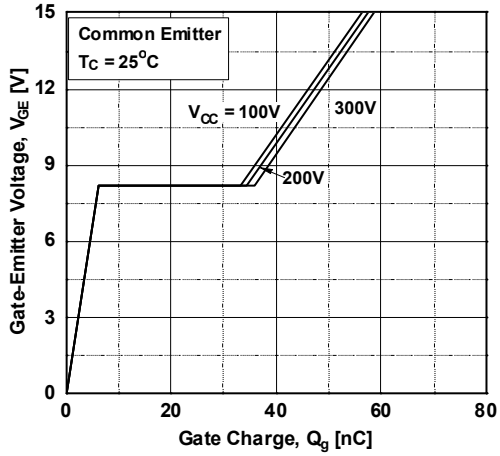



**Figure 11. SOA Characteristics**

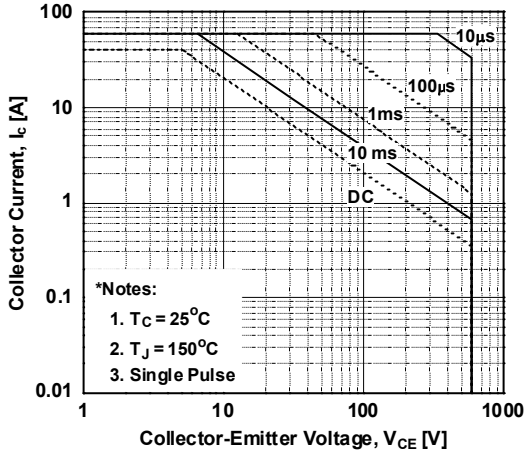
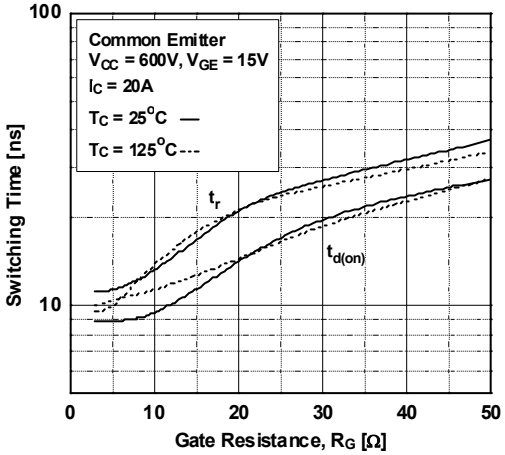



**Figure 12. Turn-on Characteristics vs. Gate Resistance**



## Typical Performance Characteristics

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

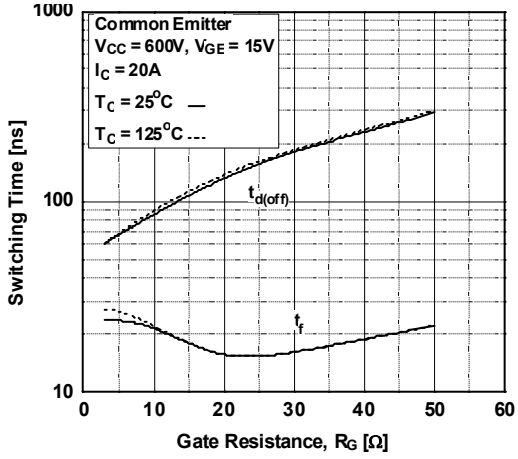



**Figure 14. Turn-on Characteristics vs. Collector Current**

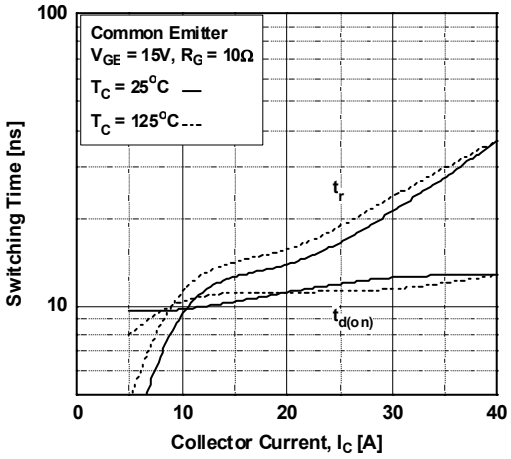



**Figure 15. Turn-off Characteristics vs. Collector Current**

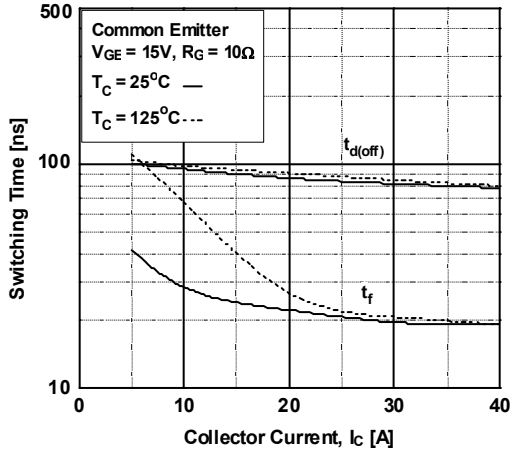



**Figure 16. Switching Loss vs. Gate Resistance**

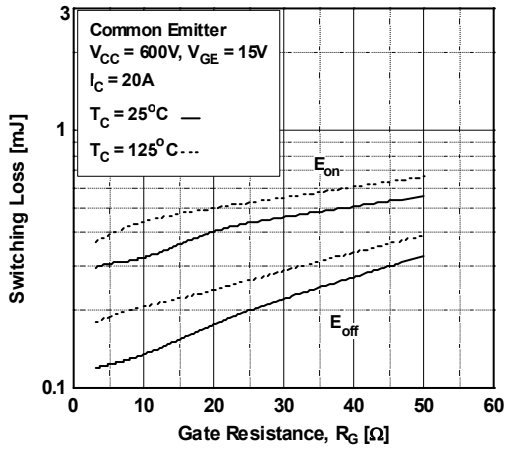



**Figure 17. Switching Loss vs. Collector Current**

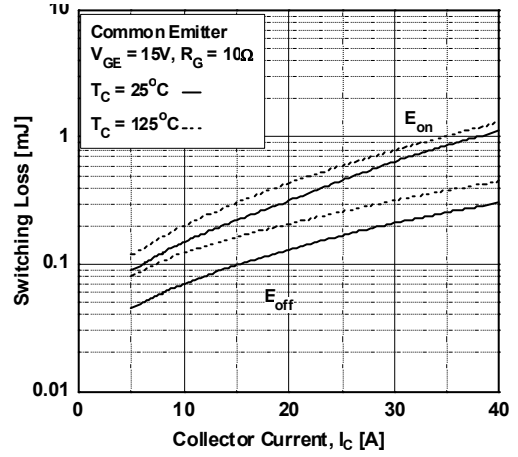
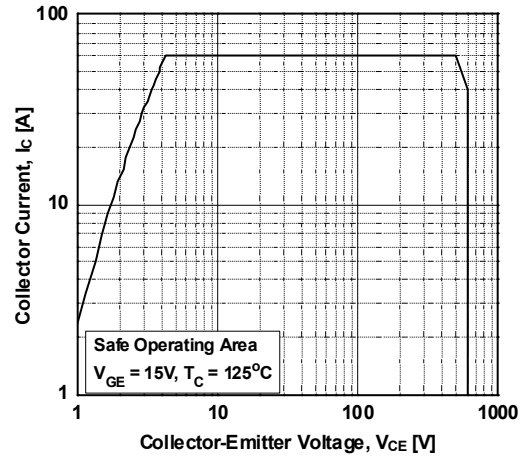



**Figure 18. Turn off Switching SOA Characteristics**



## Typical Performance Characteristics

**Figure 19. Forward Characteristics**

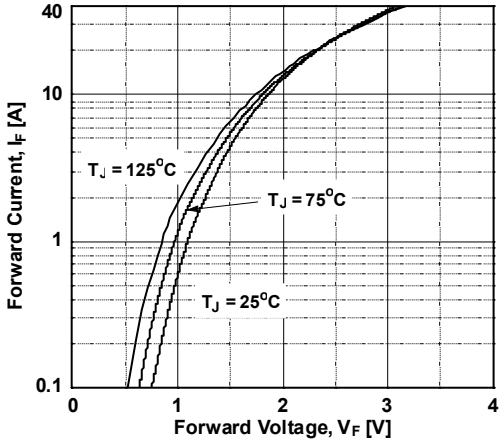



**Figure 20. Typical Reverse Current vs. Reverse Voltage**

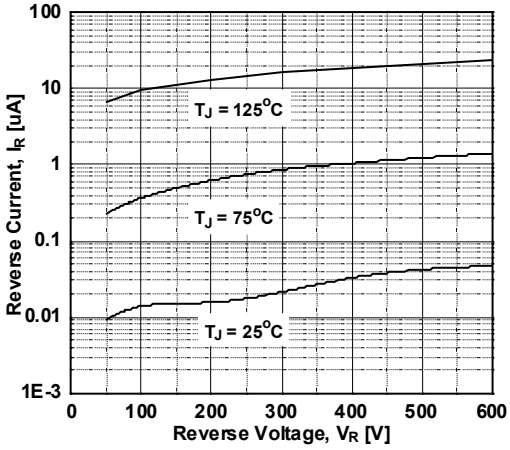



**Figure 21. Stored Charge**

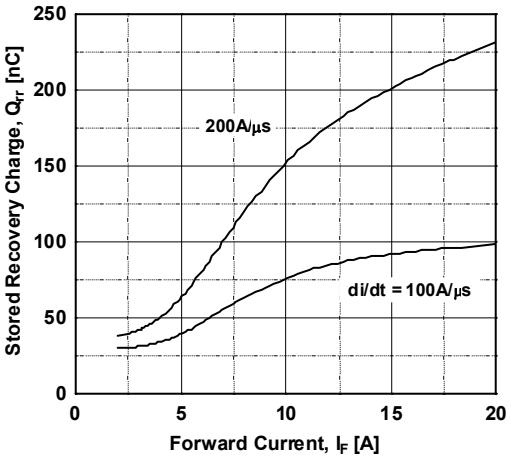



**Figure 22. Reverse Recovery Time**

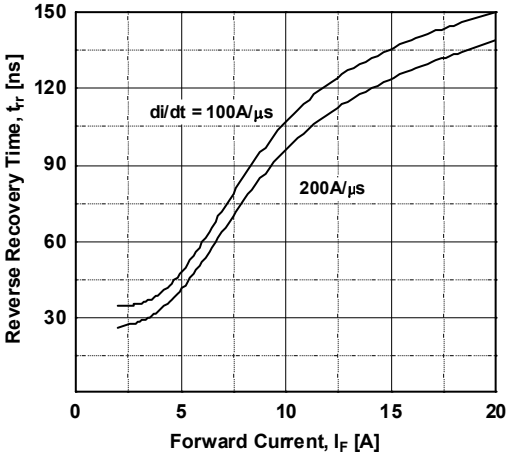
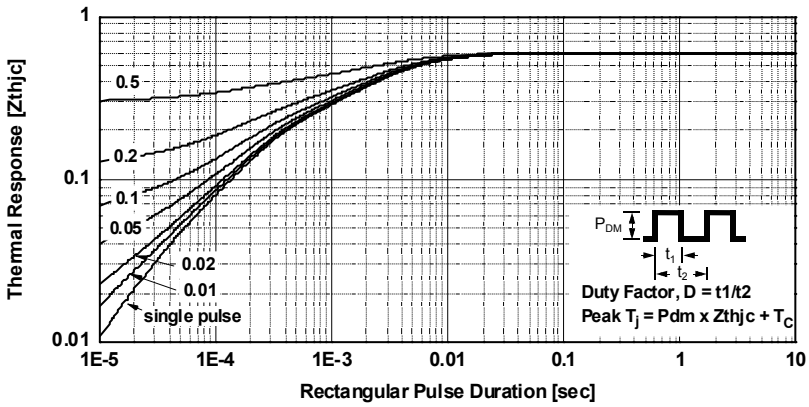
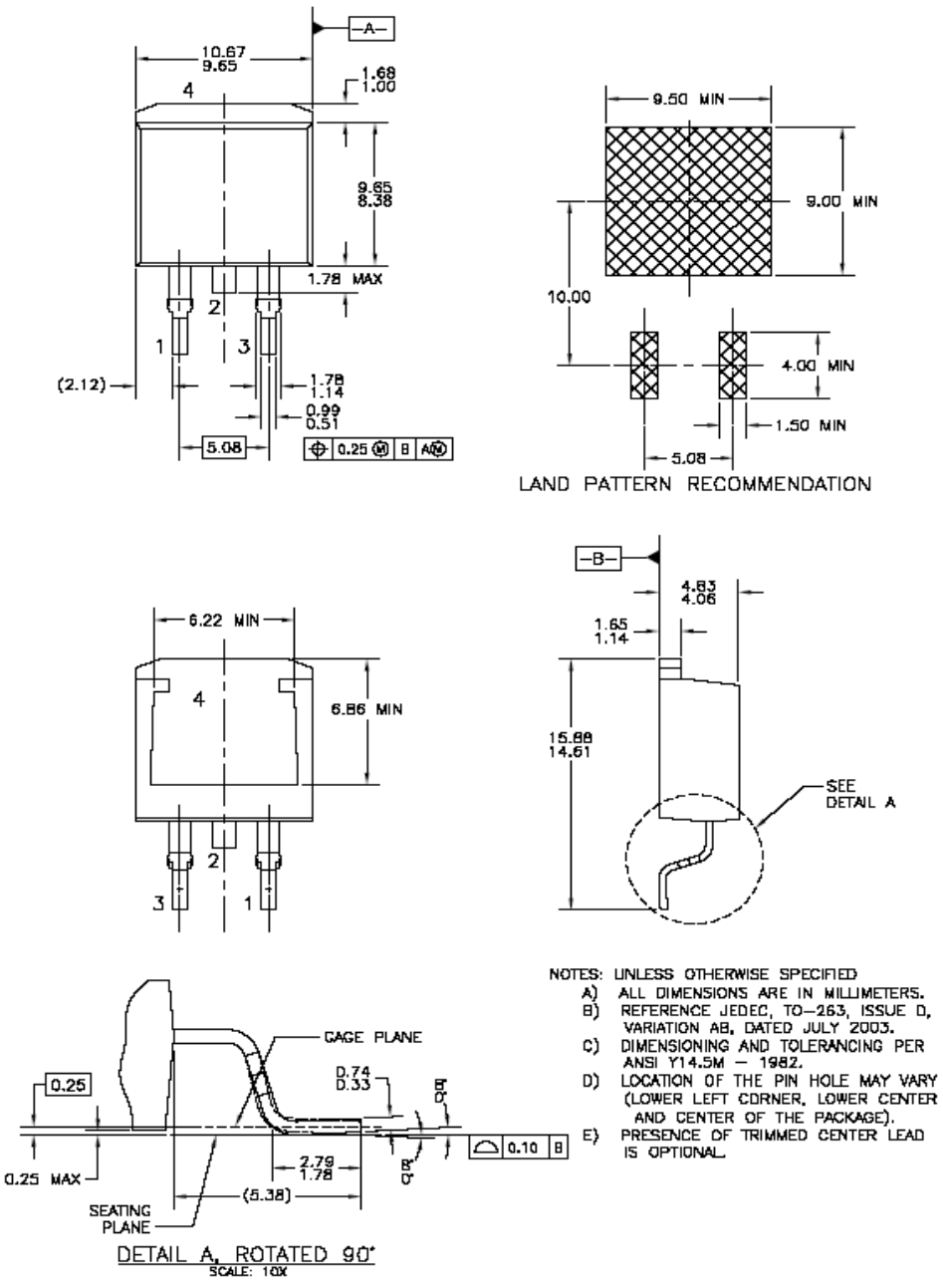



**Figure 23.Transient Thermal Impedance of IGBT**



## Mechanical Dimensions

# $D^2PAK$




Dimensions in Millimeters

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