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FAIRCHILD

May 2016

# FGA40T65UQDF
## 650 V, 40 A Field Stop Trench IGBT

## Features

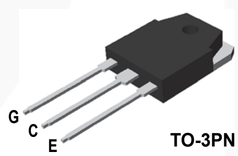
- Maximum Junction Temperature: $T_J$ = 175°C
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.33 V ( Typ.) @ $I_C$ = 40 A
- 100% of the Parts tested for $I_{LM}$(1)
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- RoHS Compliant

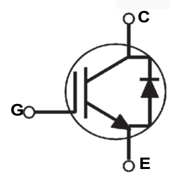
## General Description

Using novel field stop IGBT technology, Fairchild's new series of field stop 4th generation IGBTs offer superior conduction and switching performance and easy parallel operation. This device is well suited for the resonant or soft switching application such as induction heating and MWO.

## Applications

- Induction Heating, MWO




## Absolute Maximum Ratings

| Symbol | Description | | FGA40T65UQDF | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector to Emitter Voltage | | 650 | V |
| $V_{GES}$ | Gate to Emitter Voltage | | ± 20 | V |
| | Transient Gate to Emitter Voltage | | ± 30 | V |
| $I_C$ | Collector Current | @ $T_C$ = 25°C | 80 | A |
| | Collector Current | @ $T_C$ = 100°C | 40 | A |
| $I_{LM}$ (1) | Pulsed Collector Current | @ $T_C$ = 25°C | 120 | A |
| $I_{CM}$ (2) | Pulsed Collector Current | | 120 | A |
| $I_F$ | Diode Forward Current | @ $T_C$ = 25°C | 40 | A |
| | Diode Forward Current | @ $T_C$ = 100°C | 20 | A |
| $I_{FM}$ | Pulsed Diode Maximum Forward Current | | 60 | A |
| $P_D$ | Maximum Power Dissipation | @ $T_C$ = 25°C | 231 | W |
| | Maximum Power Dissipation | @ $T_C$ = 100°C | 115 | 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. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 120 A, $R_G$ = 20 Ω, Inductive Load
2. Repetitive rating: Pulse width limited by max. junction temperature

## Thermal Characteristics

| Symbol | Parameter | FGA40T65UQDF | Unit |
|---|---|---|---|
| $R_{\theta JC}$ (IGBT) | Thermal Resistance, Junction to Case, Max. | 0.65 | $^oC/W$ |
| $R_{\theta JC}$ (Diode) | Thermal Resistance, Junction to Case, Max. | 1.75 | $^oC/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40 | $^oC/W$ |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Qty per Tube |
|---|---|---|---|---|---|
| FGA40T65UQDF | FGA40T65UQDF | TO-3PN | - | - | 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 | $V_{GE}$ = 0 V, $I_C$ = 1 mA | 650 | - | - | V |
| $\Delta BV_{CES}$ / $\Delta T_J$ | Temperature Coefficient of Breakdown Voltage | $V_{GE}$ = 0 V, $I_C$ = 1 mA | - | 0.52 | - | $V/^oC$ |
| $I_{CES}$ | Collector Cut-Off Current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0 V | - | - | 250 | μA |
| $I_{GES}$ | G-E Leakage Current | $V_{GE}$ = $V_{GES}$, $V_{CE}$ = 0 V | - | - | ± 400 | nA |
| **On Characteristics** | | | | | | |
| $V_{GE(th)}$ | G-E Threshold Voltage | $I_C$ = 40 mA, $V_{CE}$ = $V_{GE}$ | 2.5 | 4.0 | 5.5 | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 40 A, $V_{GE}$ = 15 V | - | 1.33 | 1.67 | V |
| | | $I_C$ = 40 A, $V_{GE}$ = 15 V, $T_C$ = 175$^o$C | - | 1.5 | - | V |
| **Dynamic Characteristics** | | | | | | |
| $C_{ies}$ | Input Capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | - | 7309 | - | pF |
| $C_{oes}$ | Output Capacitance | | - | 58 | - | pF |
| $C_{res}$ | Reverse Transfer Capacitance | | - | 30 | - | pF |
| **Switching Characteristics** | | | | | | |
| $T_{d(on)}$ | Turn-On Delay Time | $V_{CC}$ = 400 V, $I_C$ = 40 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, $T_C$ = 25$^o$C | - | 32 | - | ns |
| $T_r$ | Rise Time | | - | 18 | - | ns |
| $T_{d(off)}$ | Turn-Off Delay Time | | - | 271 | - | ns |
| $T_f$ | Fall Time | | - | 11 | - | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 989 | - | μJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 310 | - | μJ |
| $E_{ts}$ | Total Switching Loss | | - | 1299 | - | μJ |
| $T_{d(on)}$ | Turn-On Delay Time | $V_{CC}$ = 400 V, $I_C$ = 40 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, $T_C$ = 175$^o$C | - | 30 | - | ns |
| $T_r$ | Rise Time | | - | 22 | - | ns |
| $T_{d(off)}$ | Turn-Off Delay Time | | - | 298 | - | ns |
| $T_f$ | Fall Time | | - | 16 | - | ns |
| $E_{on}$ | Turn-On Switching Loss | | - | 1400 | - | μJ |
| $E_{off}$ | Turn-Off Switching Loss | | - | 553 | - | μJ |
| $E_{ts}$ | Total Switching Loss | | - | 1953 | - | μJ |

## Electrical Characteristics of the IGBT (Continued)

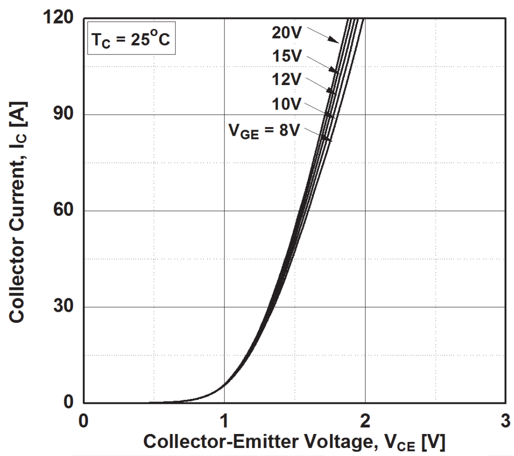
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge | $V_{CE}$ = 400 V, $I_C$ = 40 A, $V_{GE}$ = 15 V | - | 306 | - | nC |
| $Q_{ge}$ | Gate to Emitter Charge | | - | 30 | - | nC |
| $Q_{gc}$ | Gate to Collector Charge | | - | 77 | - | nC |

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

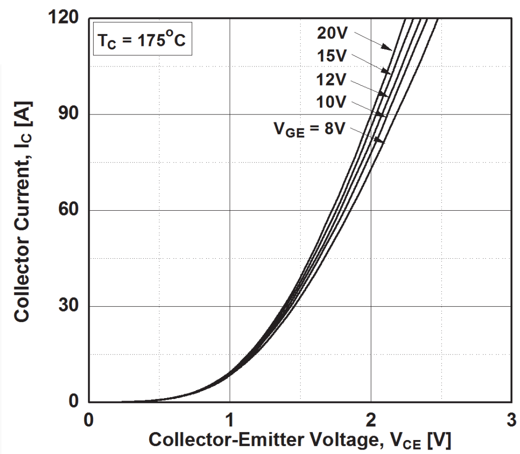
| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{FM}$ | Diode Forward Voltage | $I_F$ = 20 A | $T_C$ = 25°C | - | 1.5 | 1.95 | V |
| | | | $T_C$ = 175°C | - | 1.39 | - | |
| $E_{rec}$ | Reverse Recovery Energy | $I_F$ = 20 A, $dI_F/dt$ = 200 A/μs | $T_C$ = 175°C | - | 115 | - | μJ |
| $T_{rr}$ | Diode Reverse Recovery Time | | $T_C$ = 25°C | - | 89 | - | ns |
| | | | $T_C$ = 175°C | - | 251 | - | |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | $T_C$ = 25°C | - | 289 | - | nC |
| | | | $T_C$ = 175°C | - | 1502 | - | |

## Typical Performance Characteristics

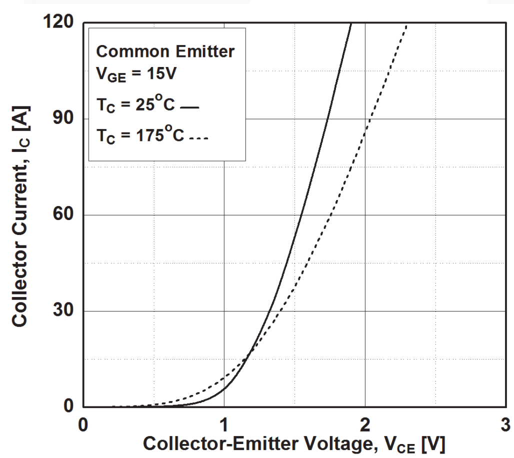
### Figure 1. Typical Output Characteristics



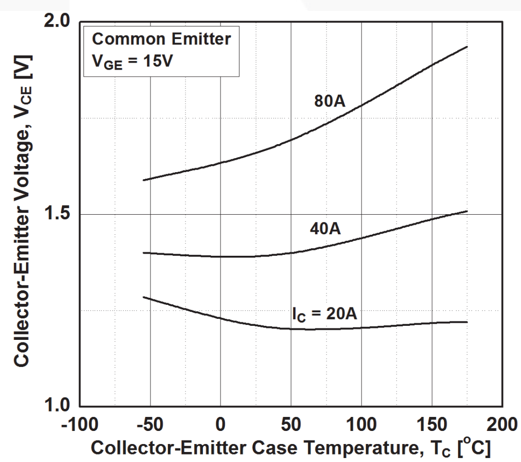

### Figure 2. Typical Output Characteristics



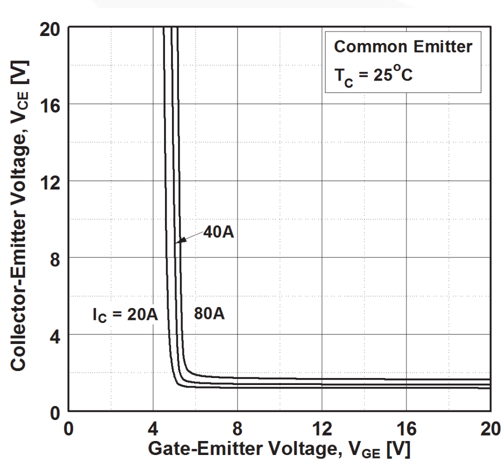

### Figure 3. Typical Saturation Voltage Characteristics



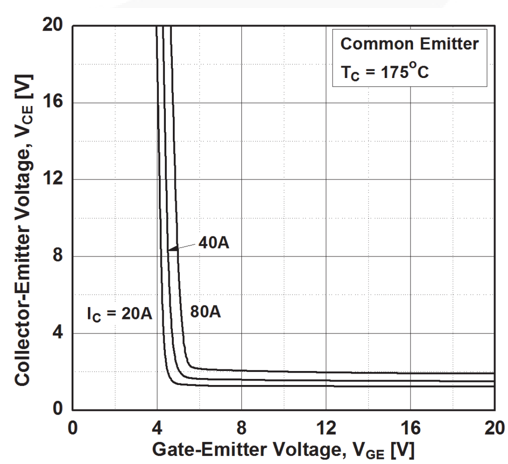

### Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level




### Figure 5. Saturation Voltage vs. $V_{GE}$

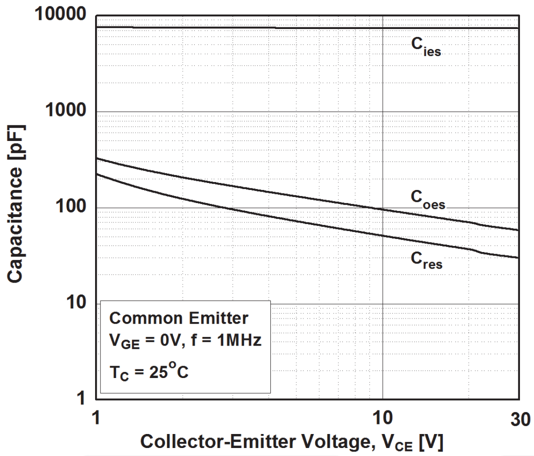



### Figure 6. Saturation Voltage vs. $V_{GE}$

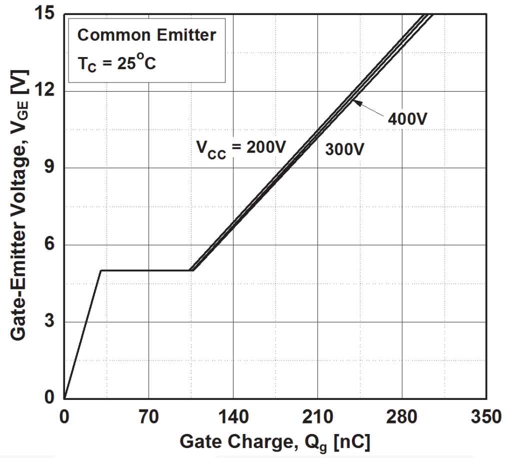


## Typical Performance Characteristics

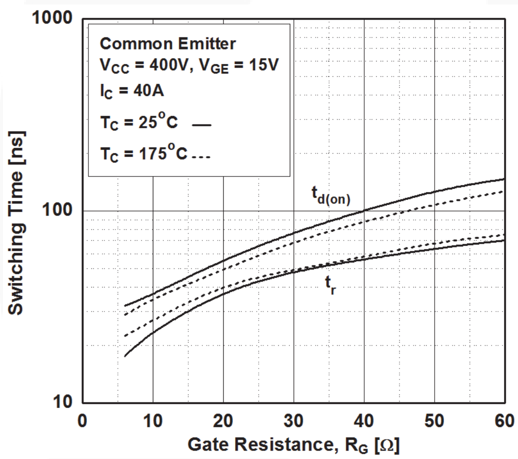
### Figure 7. Capacitance Characteristics



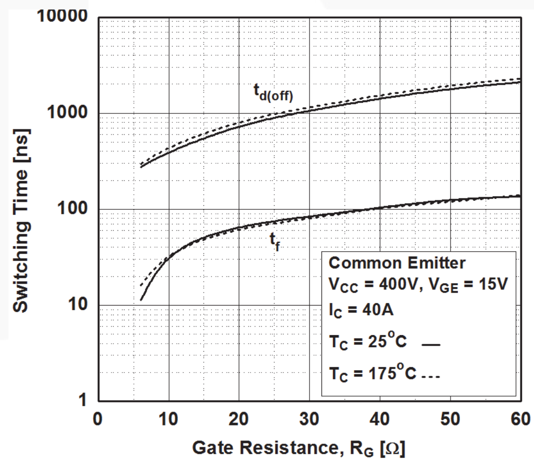

### Figure 8. Gate charge Characteristics



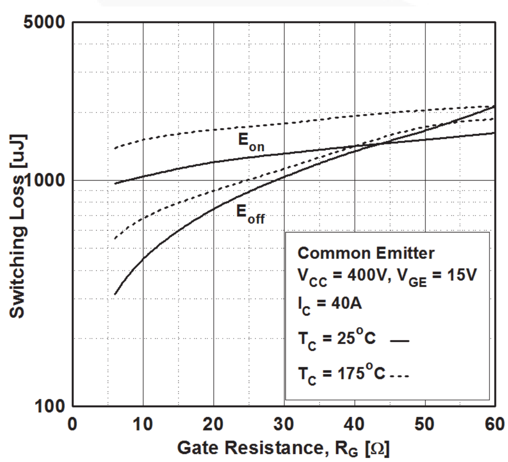

### Figure 9. Turn-on Characteristics vs. Gate Resistance



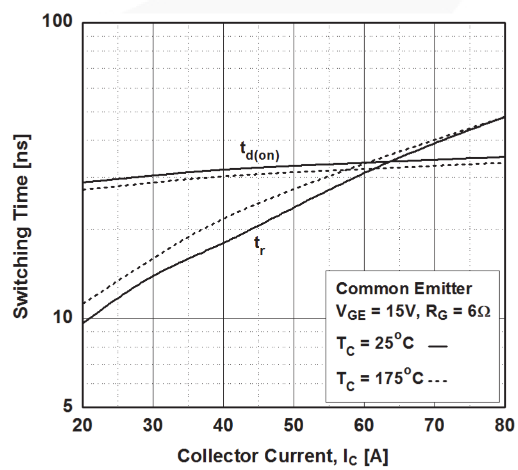

### Figure 10. Turn-off Characteristics vs. Gate Resistance




### 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**

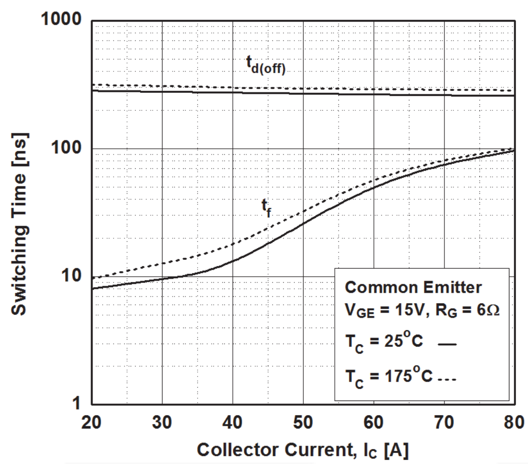



**Figure 14. Switching Loss vs. Collector Current**

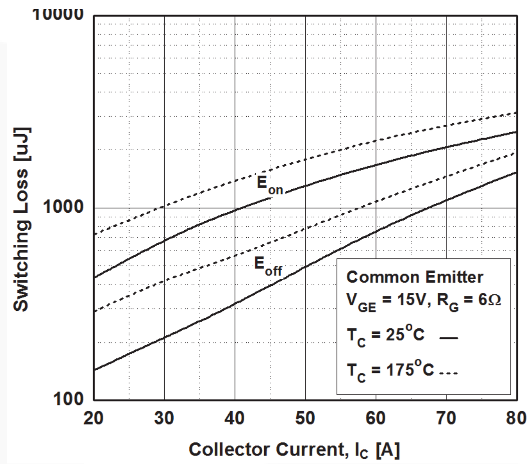



**Figure 15. Load Current Vs. Frequency**

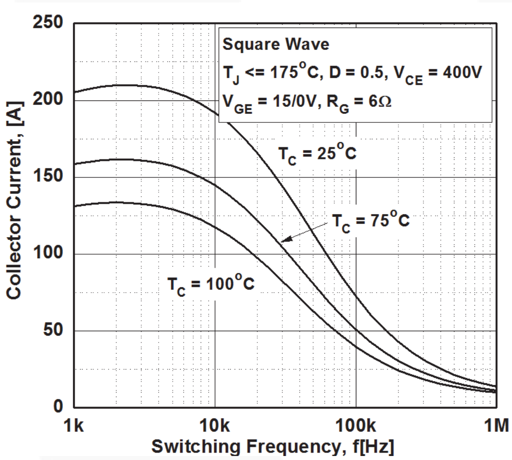



**Figure 16. SOA Characteristics**

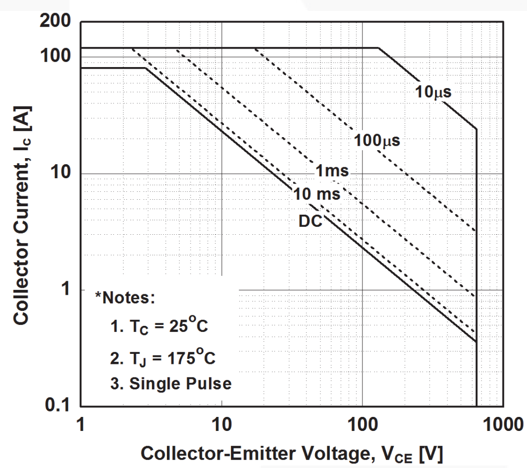



**Figure 17. Forward Characteristics**

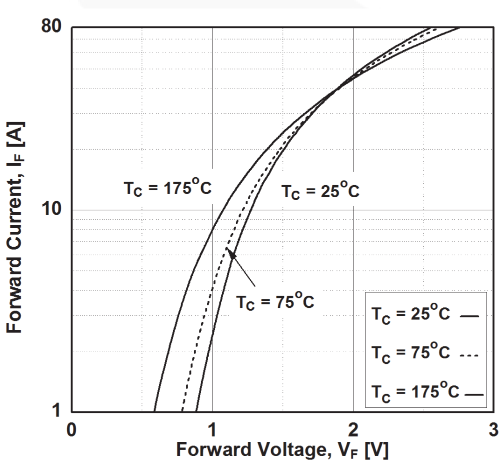
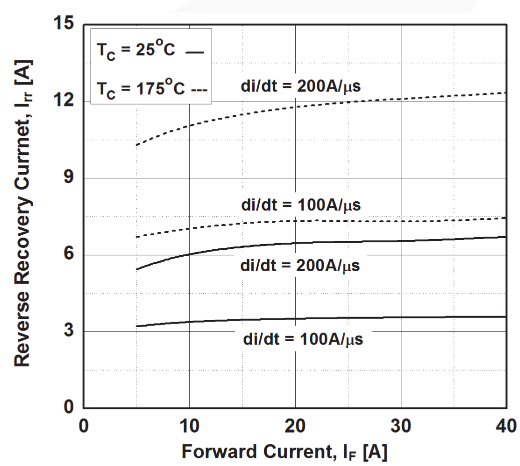



**Figure 18. Reverse Recovery Current**



## Typical Performance Characteristics

**Figure 19. Reverse Recovery Time**

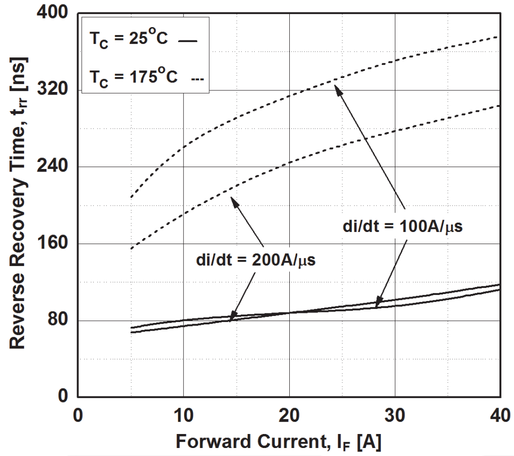



**Figure 20. Stored Charge**

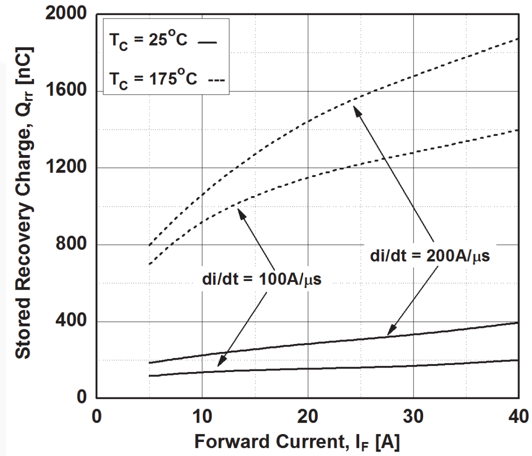



**Figure 21.Transient Thermal Impedance of IGBT**

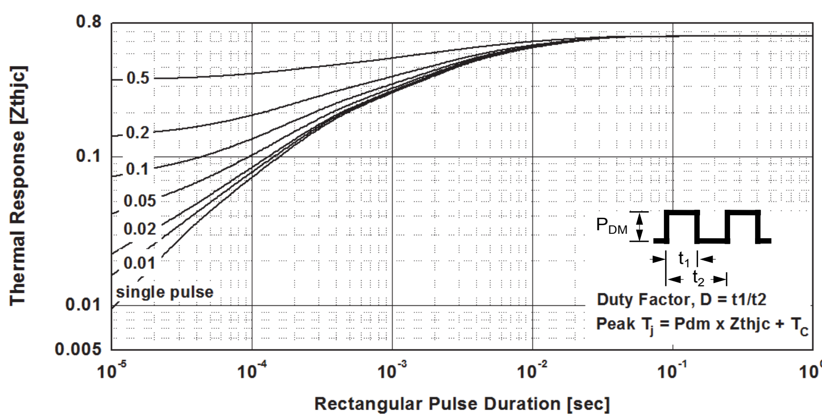
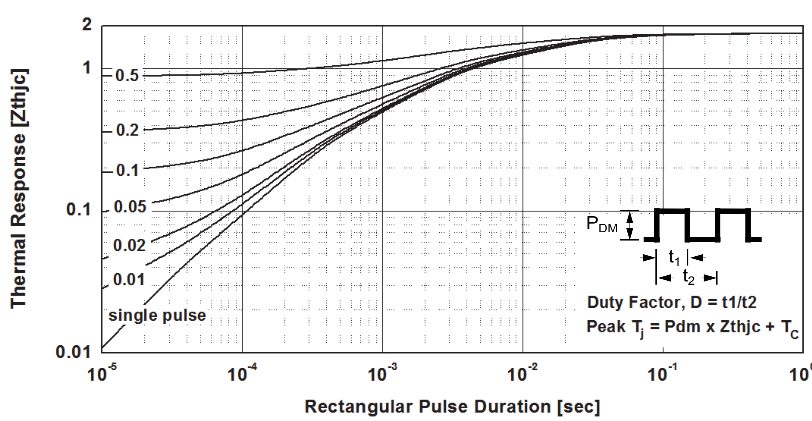



**Figure 22.Transient Thermal Impedance of Diode**



## Mechanical Dimensions

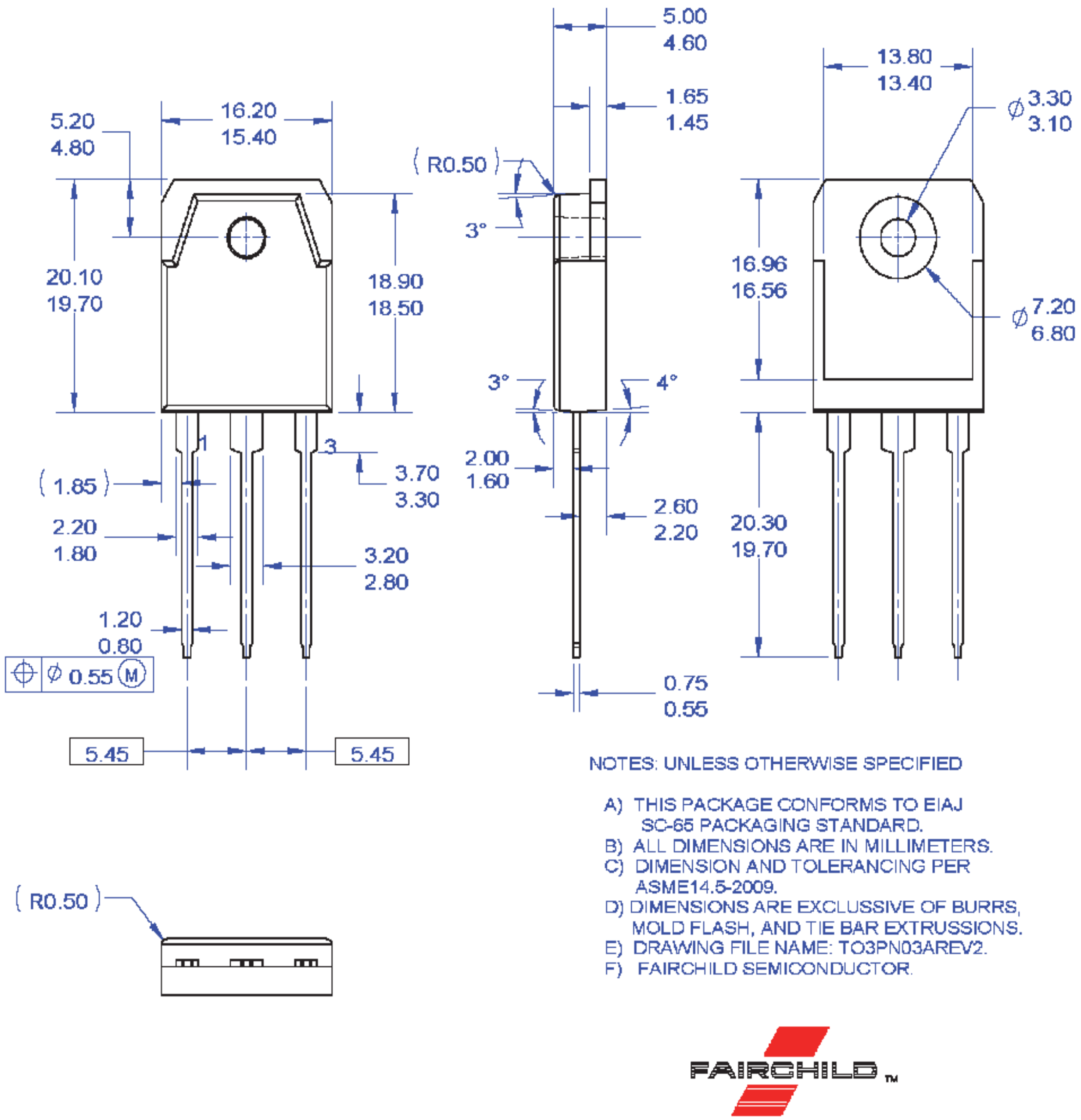



**Figure 23. TO3PN, 3-Lead, Plastic, EIAJ SC-65**

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| Datasheet Identification | Product Status | Definition |
|---|---|---|
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| 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. |
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Rev. I77

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