



April 2015

FGA6540WDF 650 V, 40 A Field Stop Trench IGBT

Features

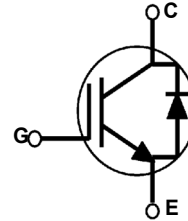
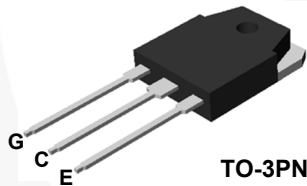
- Maximum Junction Temperature : $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)} = 1.8\text{ V(Typ.) @ } I_C = 40\text{ A}$
- 100% of the Parts Tested for $I_{LM}(1)$
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- RoHS Compliant

General Description

Using novel field stop IGBT technology, Fairchild's new series of field stop 3rd generation IGBTs offer the optimum performance for welder and industrial application where low conduction and switching losses are essential.

Applications

- Welder and Industrial Application
- Power Factor Correction



Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Description | FGA6540WDF | 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 @ $T_C = 25^\circ\text{C}$ | 80 | A |
| | Collector Current @ $T_C = 100^\circ\text{C}$ | 40 | A |
| $I_{LM}(1)$ | Pulsed Collector Current @ $T_C = 25^\circ\text{C}$ | 120 | A |
| $I_{CM}(2)$ | Pulsed Collector Current | 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 |
| $I_{FM}(2)$ | Pulsed Diode Maximum Forward Current | 120 | A |
| P_D | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$ | 238 | W |
| | Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$ | 119 | W |
| 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. $V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $I_C = 120\text{ A}$, $R_G = 60\ \Omega$, Inductive Load
2. Repetitive rating: Pulse width limited by max. junction temperature

FGA6540WDF — 650 V, 40 A Field Stop Trench IGBT

Thermal Characteristics

| Symbol | Parameter | FGA6540WDF | Unit |
|------------------------|---|------------|---------------|
| $R_{\theta JC}(IGBT)$ | Thermal Resistance, Junction to Case, Max. | 0.63 | $^{\circ}C/W$ |
| $R_{\theta JC}(Diode)$ | Thermal Resistance, Junction to Case, Max. | 1.75 | $^{\circ}C/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40 | $^{\circ}C/W$ |

Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Qty per Tube |
|-------------|------------|---------|----------------|-----------|------------|--------------|
| FGA6540WDF | FGA6540WDF | TO-3PN | Tube | - | - | 30 |

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

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|----------------------------------|--|--|------|------|-----------|---------------|
| Off Characteristics | | | | | | |
| BV_{CES} | Collector to Emitter Breakdown Voltage | $V_{GE} = 0V, I_C = 1\text{ mA}$ | 650 | - | - | V |
| $\Delta BV_{CES} / \Delta T_J$ | Temperature Coefficient of Breakdown Voltage | $I_C = 1\text{ mA}$, Reference to $25^{\circ}C$ | - | 0.6 | - | $V/^{\circ}C$ |
| I_{CES} | Collector Cut-Off Current | $V_{CE} = V_{CES}, V_{GE} = 0\text{ V}$ | - | - | 250 | μA |
| I_{GES} | G-E Leakage Current | $V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$ | - | - | ± 400 | nA |
| On Characteristics | | | | | | |
| $V_{GE(th)}$ | G-E Threshold Voltage | $I_C = 40\text{ mA}, V_{CE} = V_{GE}$ | 4.1 | 5.6 | 7.6 | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C = 40\text{ A}, V_{GE} = 15\text{ V}$ | - | 1.8 | 2.3 | V |
| | | $I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_C = 175^{\circ}C$ | - | 2.31 | - | V |
| Dynamic Characteristics | | | | | | |
| C_{ies} | Input Capacitance | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ | - | 1525 | - | pF |
| C_{oes} | Output Capacitance | | - | 60 | - | pF |
| C_{res} | Reverse Transfer Capacitance | | - | 20 | - | pF |
| Switching Characteristics | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 25^{\circ}C$ | - | 16.8 | - | ns |
| t_r | Rise Time | | - | 34.4 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 54.4 | - | ns |
| t_f | Fall Time | | - | 10 | - | ns |
| E_{on} | Turn-On Switching Loss | | - | 1.37 | - | mJ |
| E_{off} | Turn-Off Switching Loss | | - | 0.25 | - | mJ |
| E_{ts} | Total Switching Loss | | - | 1.62 | - | mJ |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 175^{\circ}C$ | - | 16 | - | ns |
| t_r | Rise Time | | - | 35.2 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 57.6 | - | ns |
| t_f | Fall Time | | - | 12.8 | - | ns |
| E_{on} | Turn-On Switching Loss | | - | 1.89 | - | mJ |
| E_{off} | Turn-Off Switching Loss | | - | 0.47 | - | mJ |
| E_{ts} | Total Switching Loss | | - | 2.36 | - | mJ |

Electrical Characteristics of the IGBT (Continued)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max | Unit |
|----------|--------------------------|---|------|------|-----|------|
| Q_g | Total Gate Charge | $V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$ | - | 55.5 | - | nC |
| Q_{ge} | Gate to Emitter Charge | | - | 9.8 | - | nC |
| Q_{gc} | Gate to Collector Charge | | - | 21 | - | 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 | $I_F = 20\text{ A}$ | $T_C = 25^\circ\text{C}$ | - | 1.5 | 1.95 | V |
| | | | $T_C = 175^\circ\text{C}$ | - | 1.37 | - | |
| E_{rec} | Reverse Recovery Energy | $I_F = 20\text{ A}$, $dI_F/dt = 200\text{ A}/\mu\text{s}$ | $T_C = 175^\circ\text{C}$ | - | 153 | - | uJ |
| t_{rr} | Diode Reverse Recovery Time | | $T_C = 25^\circ\text{C}$ | - | 101 | - | ns |
| | | | $T_C = 175^\circ\text{C}$ | - | 238 | - | |
| Q_{rr} | Diode Reverse Recovery Charge | | $T_C = 25^\circ\text{C}$ | - | 343 | - | nC |
| | | $T_C = 175^\circ\text{C}$ | - | 1493 | - | | |

Typical Performance Characteristics

Figure 1. Typical Output Characteristics

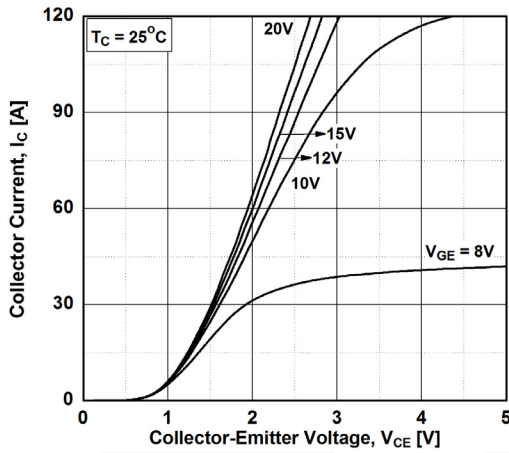


Figure 2. Typical Output Characteristics

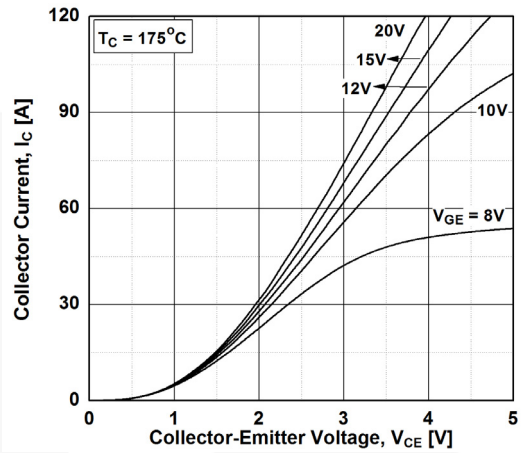


Figure 3. Typical Saturation Voltage Characteristics

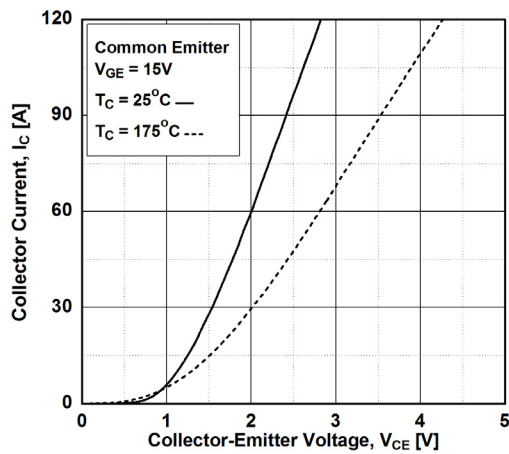


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

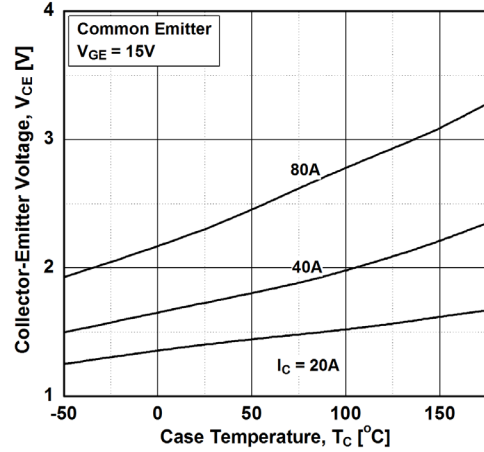


Figure 5. Saturation Voltage vs. V_{GE}

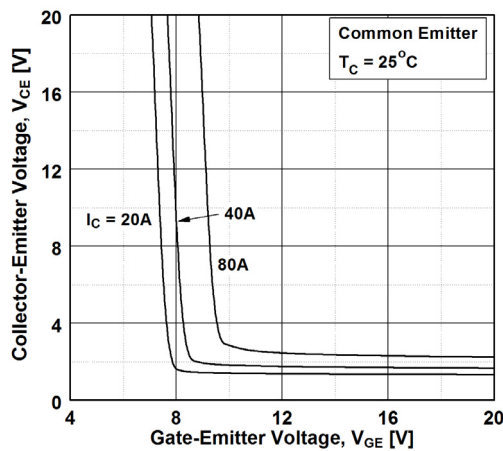
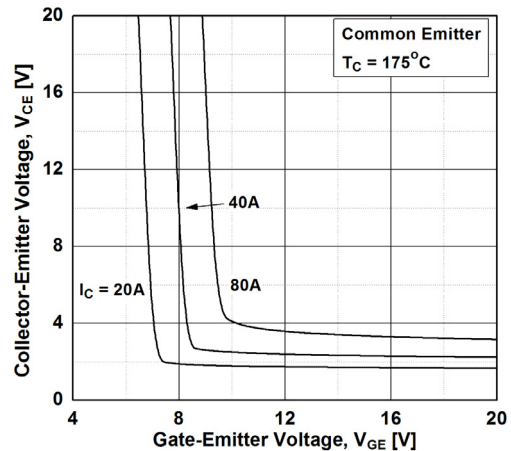


Figure 6. Saturation Voltage vs. V_{GE}



Typical Performance Characteristics

Figure 7. Capacitance Characteristics

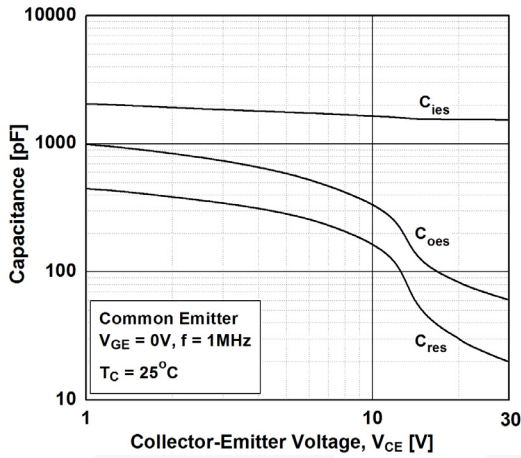


Figure 8. Gate charge Characteristics

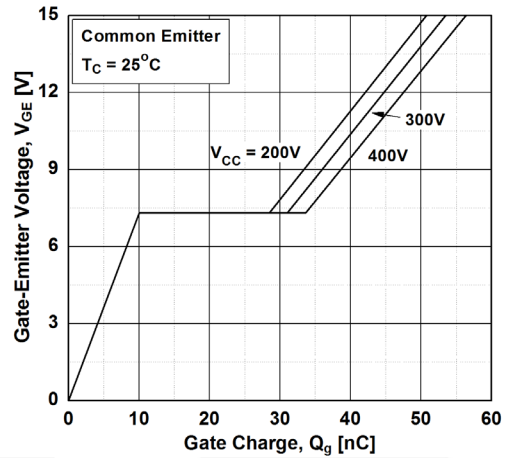


Figure 9. Turn-on Characteristics vs. Gate Resistance

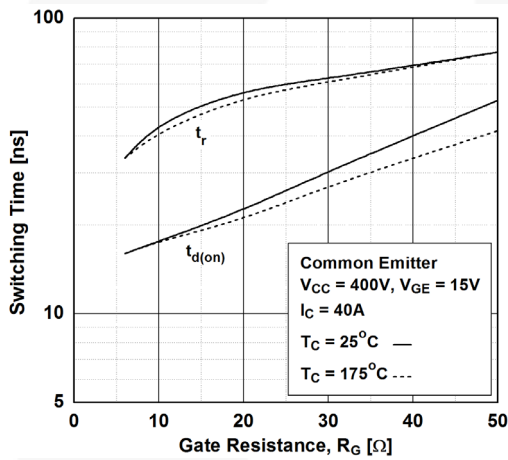


Figure 10. Turn-off Characteristics vs. Gate Resistance

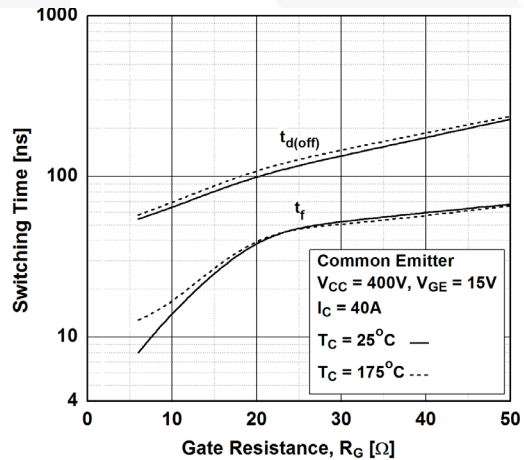


Figure 11. Switching Loss vs. Gate Resistance

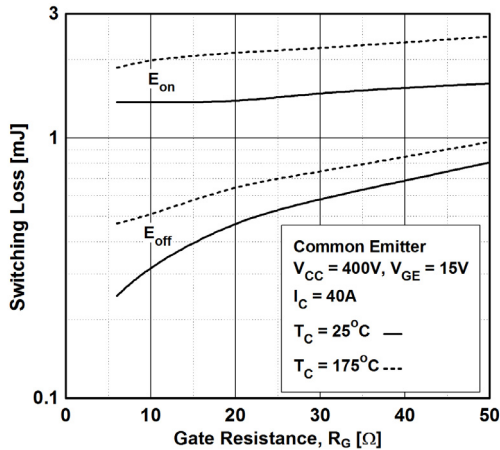
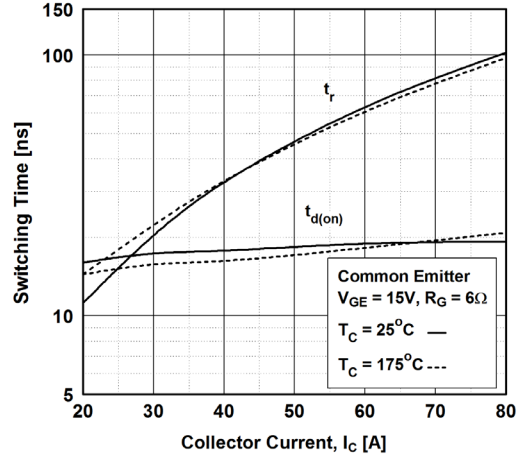


Figure 12. Turn-on Characteristics vs. Collector Current



Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Collector Current

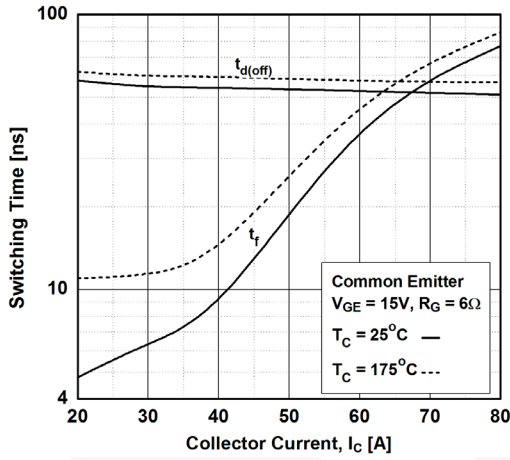


Figure 14. Switching Loss vs. Collector Current

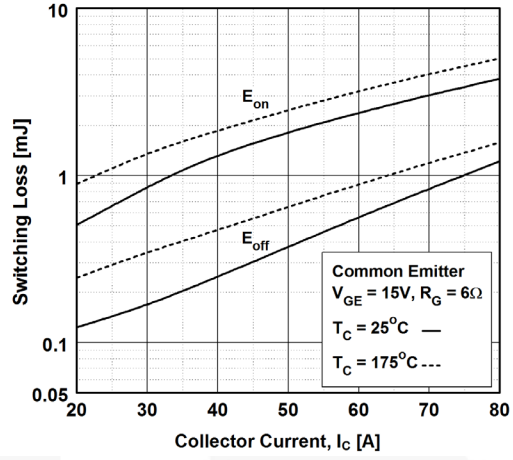


Figure 15. Load Current Vs. Frequency

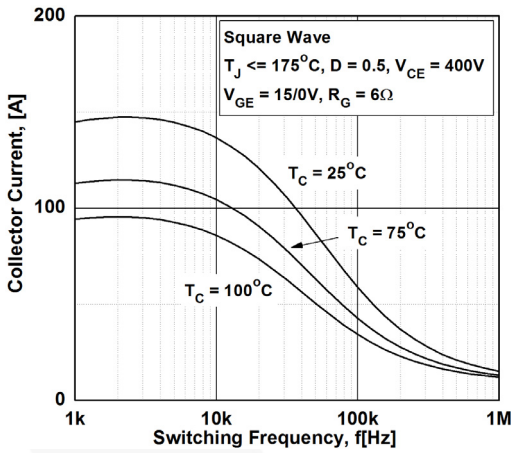


Figure 16. SOA Characteristics

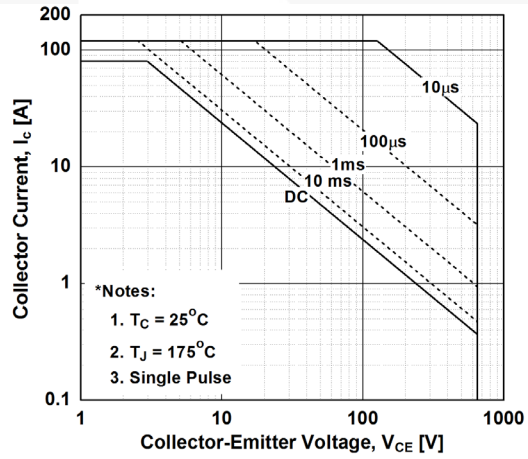


Figure 17. Forward Characteristics

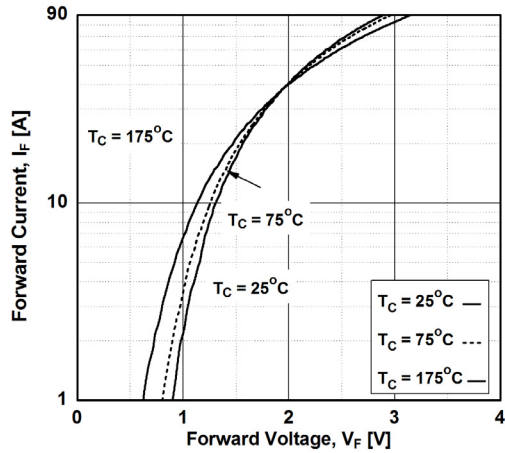
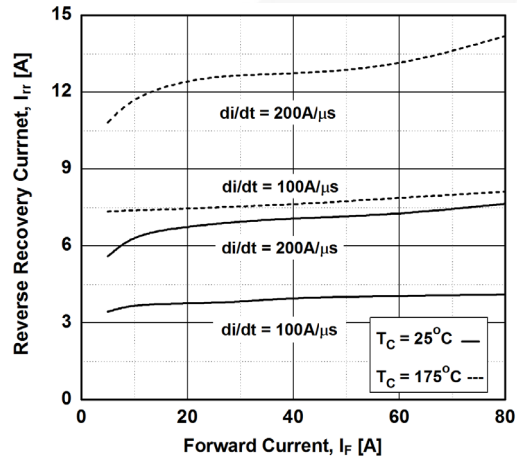


Figure 18. Reverse Recovery Current



Typical Performance Characteristics

Figure 19. Reverse Recovery Time

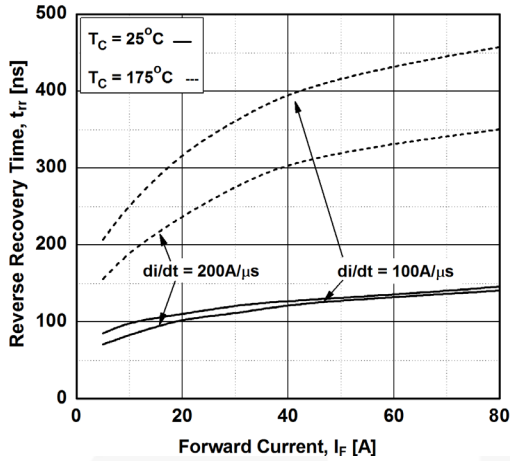


Figure 20. Stored Charge

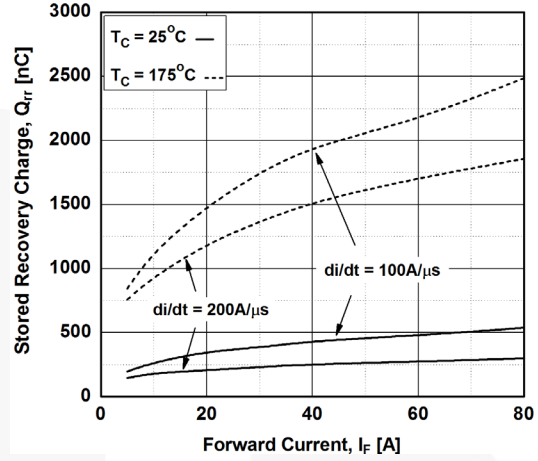


Figure 21. Transient Thermal Impedance of IGBT

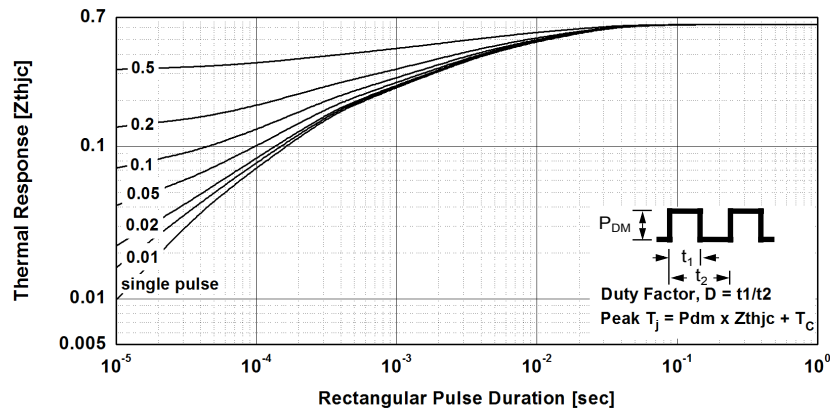
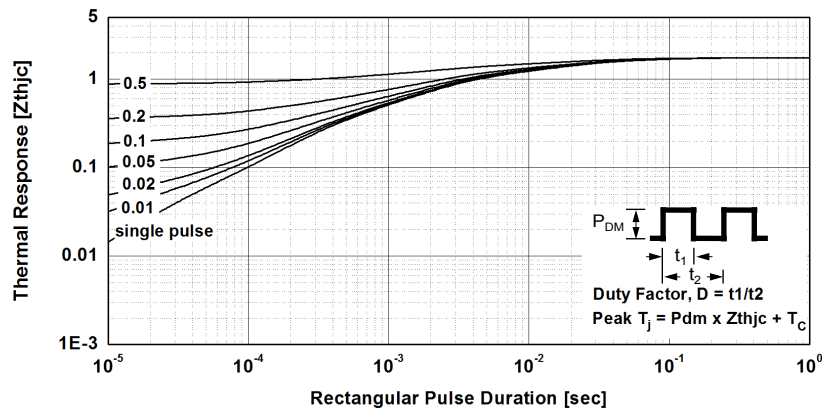
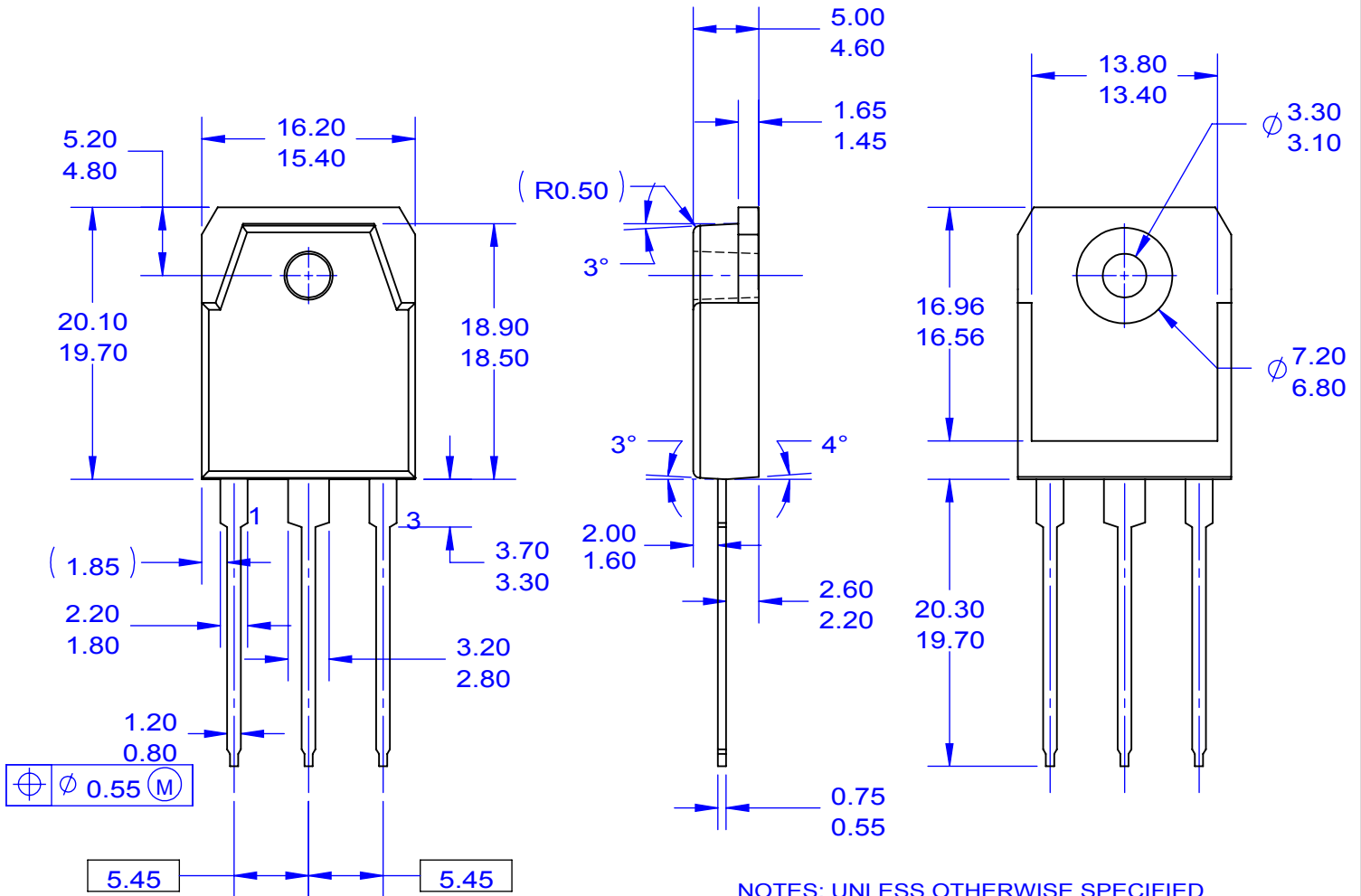


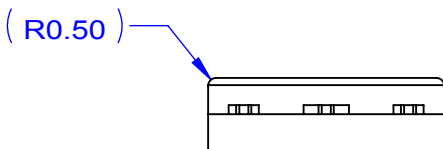
Figure 22. Transient Thermal Impedance of Diode





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