



March 2015

# FGH40N60UFD

## 600 V, 40 A Field Stop IGBT

### Features

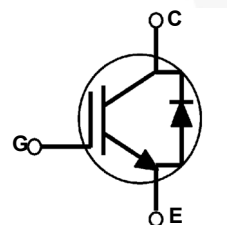
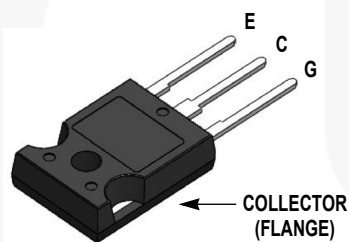
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.8 \text{ V @ } I_C = 40 \text{ A}$
- High Input Impedance
- Fast Switching
- RoHS Compliant

### Applications

- Solar Inverter, UPS, Welder, PFC, Microwave Oven, Telecom, ESS

### General Description

Using novel field stop IGBT technology, Fairchild's field stop IGBTs offer the optimum performance for solar inverter, UPS, welder, microwave oven, telecom, ESS and PFC applications where low conduction and switching losses are essential.



### Absolute Maximum Ratings

| Symbol      | Description   | Ratings     | Unit             |
|-------------|---|-------------|------------------|
| $V_{CES}$   | Collector to Emitter Voltage  | 600         | V                |
| $V_{GES}$   | Gate to Emitter Voltage   | $\pm 20$    | V                |
|             | Transient Gate-to-Emitter Voltage                                       | $\pm 30$    | V                |
| $I_C$       | Collector Current @ $T_C = 25^\circ\text{C}$                            | 80          | A                |
|             | Collector Current @ $T_C = 100^\circ\text{C}$                           | 40          | A                |
| $I_{CM(1)}$ | Pulsed Collector Current @ $T_C = 25^\circ\text{C}$                     | 120         | A                |
| $P_D$       | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$                    | 290         | W                |
|             | Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$                   | 116         | W                |
| $T_J$       | Operating Junction Temperature  | -55 to +150 | $^\circ\text{C}$ |
| $T_{stg}$   | Storage Temperature Range   | -55 to +150 | $^\circ\text{C}$ |
| $T_L$       | Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds | 300         | $^\circ\text{C}$ |

#### Notes:

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

### Thermal Characteristics

| Symbol                        | Parameter                               | Typ. | Max. | Unit               |
|-------------------------------|---|------|------|--------------------|
| $R_{\theta JC}(\text{IGBT})$  | Thermal Resistance, Junction to Case    | -    | 0.43 | $^\circ\text{C/W}$ |
| $R_{\theta JC}(\text{Diode})$ | Thermal Resistance, Junction to Case    | -    | 1.45 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$               | Thermal Resistance, Junction to Ambient | -    | 40   | $^\circ\text{C/W}$ |

FGH40N60UFD — 600 V, 40 A Field Stop IGBT

## Package Marking and Ordering Information

| Part Number  | Top Mark    | Package | Packing Method | Reel Size | Tape Width | Quantity |
|--------------|-------------|---------|----------------|-----------|------------|----------|
| FGH40N60UFDU | FGH40N60UFD | TO-247  | Tube           | N/A       | N/A        | 30       |

## Electrical Characteristics of the IGBT T<sub>C</sub> = 25°C unless otherwise noted

| Symbol                               | Parameter                                    | Test Conditions   | Min. | Typ. | Max. | Unit |
|--------------------------------------|--|---|------|------|------|------|
| Off Characteristics                  |  |   |      |      |      |      |
| BV <sub>CES</sub>                    | Collector to Emitter Breakdown Voltage       | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA  | 600  | -    | -    | V    |
| $\frac{\Delta BV_{CES}}{\Delta T_J}$ | Temperature Coefficient of Breakdown Voltage | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA  | -    | 0.6  | -    | V/°C |
| I <sub>CES</sub>                     | Collector Cut-Off Current                    | V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V  | -    | -    | 250  | μA   |
| I <sub>GES</sub>                     | G-E Leakage Current                          | V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V  | -    | -    | ±400 | nA   |
| On Characteristics                   |  |   |      |      |      |      |
| V <sub>GE(th)</sub>                  | G-E Threshold Voltage                        | I <sub>C</sub> = 250 μA, V <sub>CE</sub> = V <sub>GE</sub>  | 4.0  | 5.0  | 6.5  | V    |
| V <sub>CE(sat)</sub>                 | Collector to Emitter Saturation Voltage      | I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V   | -    | 1.8  | 2.4  | V    |
|                                      |  | I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 125°C   | -    | 2.0  | -    | V    |
| Dynamic Characteristics              |  |   |      |      |      |      |
| C <sub>ies</sub>                     | Input Capacitance                            | V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz  | -    | 2110 | -    | pF   |
| C <sub>oes</sub>                     | Output Capacitance                           |   | -    | 200  | -    | pF   |
| C <sub>res</sub>                     | Reverse Transfer Capacitance                 |   | -    | 60   | -    | pF   |
| Switching Characteristics            |  |   |      |      |      |      |
| t <sub>d(on)</sub>                   | Turn-On Delay Time                           | V <sub>CC</sub> = 400 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 25°C  | -    | 24   | -    | ns   |
| t <sub>r</sub>                       | Rise Time                                    |   | -    | 44   | -    | ns   |
| t <sub>d(off)</sub>                  | Turn-Off Delay Time                          |   | -    | 112  | -    | ns   |
| t <sub>f</sub>                       | Fall Time                                    |   | -    | 30   | 60   | ns   |
| E <sub>on</sub>                      | Turn-On Switching Loss                       |   | -    | 1.19 | -    | mJ   |
| E <sub>off</sub>                     | Turn-Off Switching Loss                      |   | -    | 0.46 | -    | mJ   |
| E <sub>ts</sub>                      | Total Switching Loss                         |   | -    | 1.65 | -    | mJ   |
| t <sub>d(on)</sub>                   | Turn-On Delay Time                           | V <sub>CC</sub> = 400 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 125°C | -    | 24   | -    | ns   |
| t <sub>r</sub>                       | Rise Time                                    |   | -    | 45   | -    | ns   |
| t <sub>d(off)</sub>                  | Turn-Off Delay Time                          |   | -    | 120  | -    | ns   |
| t <sub>f</sub>                       | Fall Time                                    |   | -    | 40   | -    | ns   |
| E <sub>on</sub>                      | Turn-On Switching Loss                       |   | -    | 1.2  | -    | mJ   |
| E <sub>off</sub>                     | Turn-Off Switching Loss                      |   | -    | 0.69 | -    | mJ   |
| E <sub>ts</sub>                      | Total Switching Loss                         |   | -    | 1.89 | -    | mJ   |
| Q <sub>g</sub>                       | Total Gate Charge                            | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V  | -    | 120  | -    | nC   |
| Q <sub>ge</sub>                      | Gate to Emitter Charge                       |   | -    | 14   | -    | nC   |
| Q <sub>gc</sub>                      | Gate to Collector Charge                     |   | -    | 58   | -    | 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         | $I_F = 20\text{ A}$                                     | $T_C = 25^\circ\text{C}$  | -    | 1.95 | 2.6 | V    |
|          |                               |   | $T_C = 125^\circ\text{C}$ | -    | 1.85 | -   |      |
| $t_{rr}$ | Diode Reverse Recovery Time   | $I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$ | $T_C = 25^\circ\text{C}$  | -    | 45   | -   | ns   |
|          |                               |   | $T_C = 125^\circ\text{C}$ | -    | 140  | -   |      |
| $Q_{rr}$ | Diode Reverse Recovery Charge | $I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$ | $T_C = 25^\circ\text{C}$  | -    | 75   | -   | nC   |
|          |                               |   | $T_C = 125^\circ\text{C}$ | -    | 375  | -   |      |

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

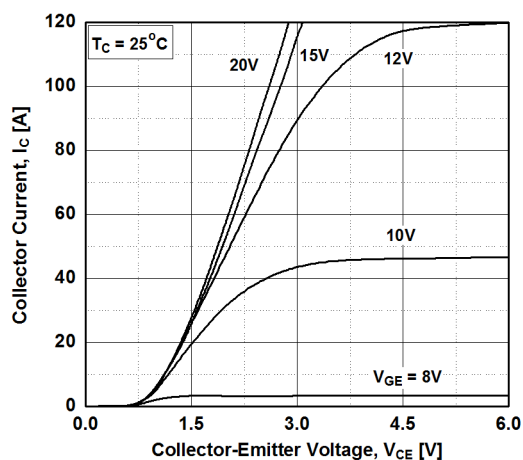


Figure 2. Typical Output Characteristics

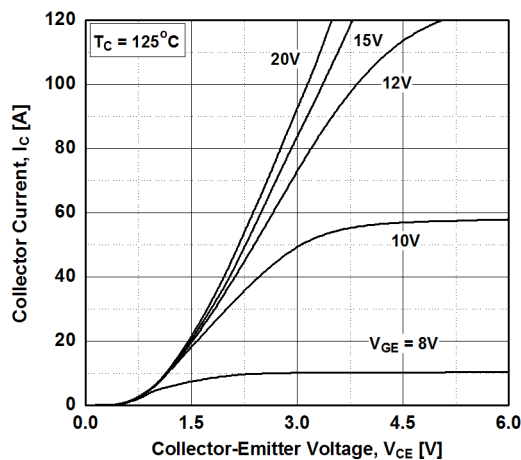


Figure 3. Typical Saturation Voltage Characteristics

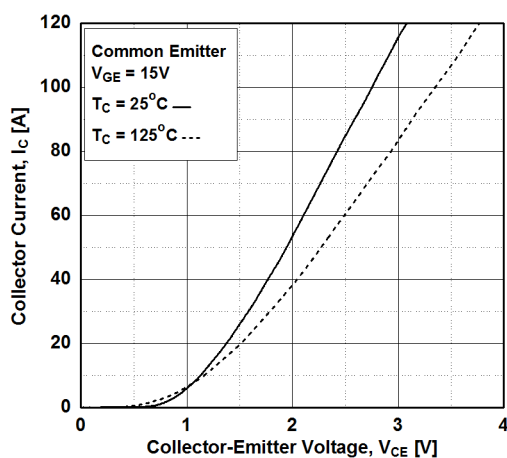


Figure 4. Transfer Characteristics

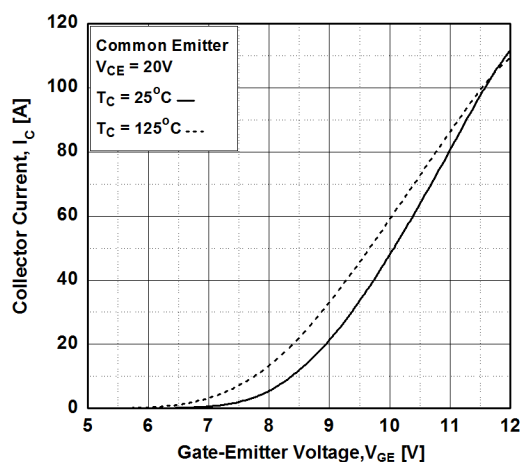


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

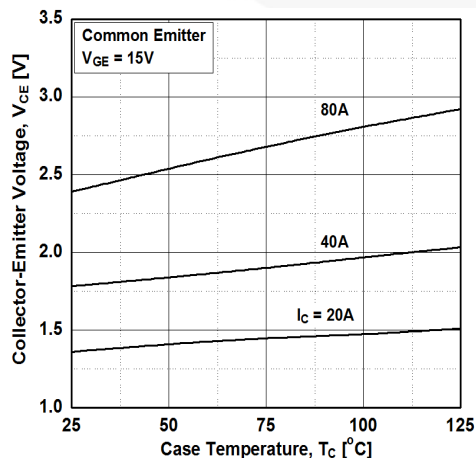
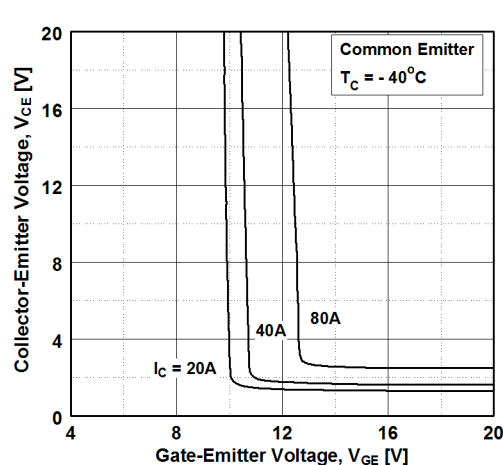


Figure 6. Saturation Voltage vs. V\_GE



## Typical Performance Characteristics

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

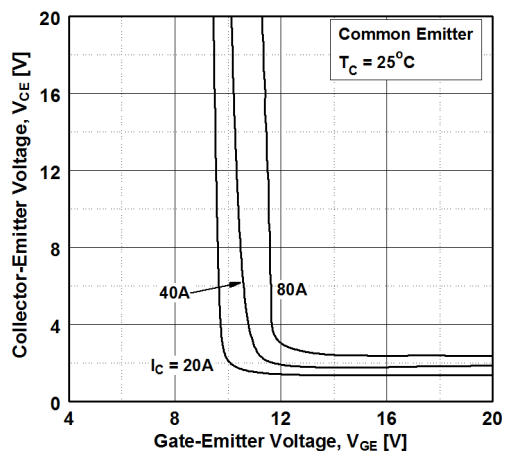


Figure 8. Saturation Voltage vs.  $V_{GE}$

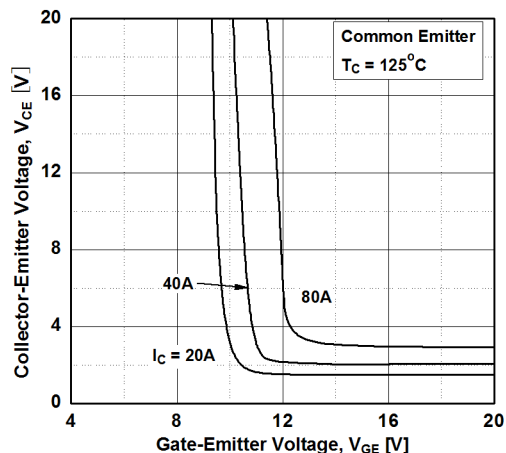


Figure 9. Capacitance Characteristics

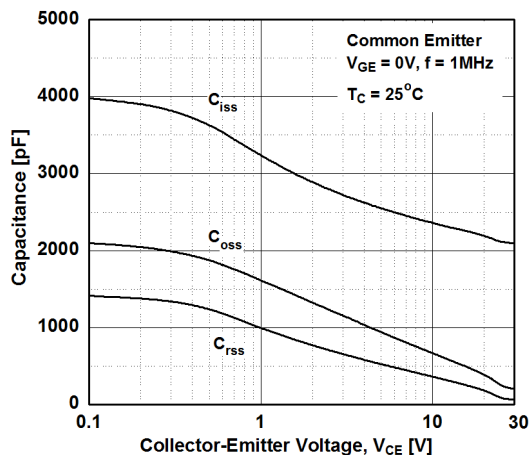


Figure 10. Gate charge Characteristics

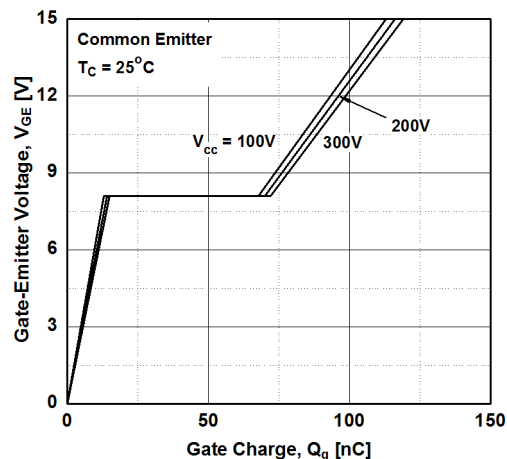


Figure 11. SOA Characteristics

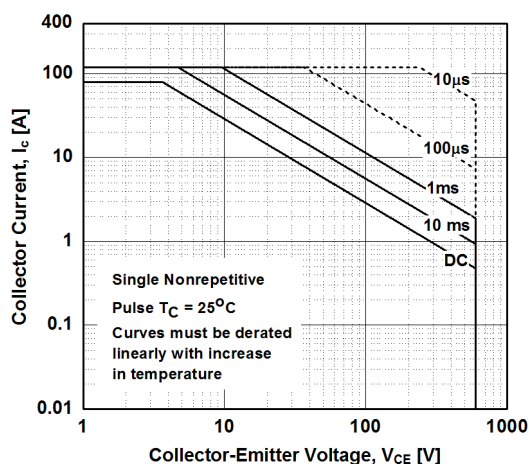
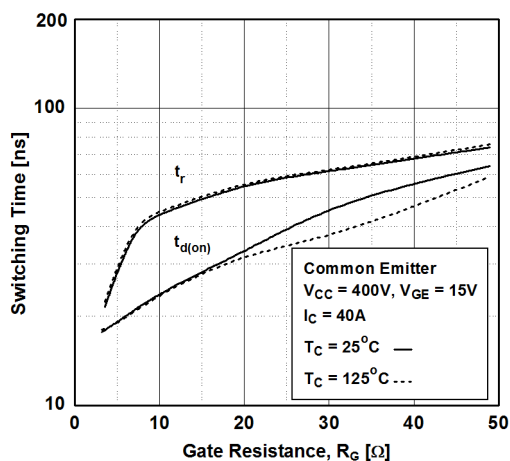


Figure 12. Turn-on Characteristics vs. Gate Resistance



## Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Gate Resistance

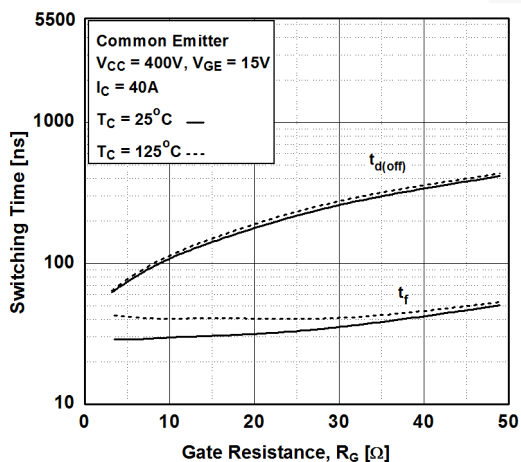


Figure 14. Turn-on Characteristics vs. Collector Current

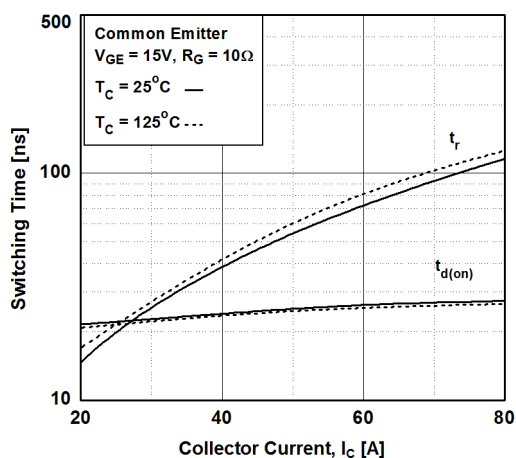


Figure 15. Turn-off Characteristics vs. Collector Current

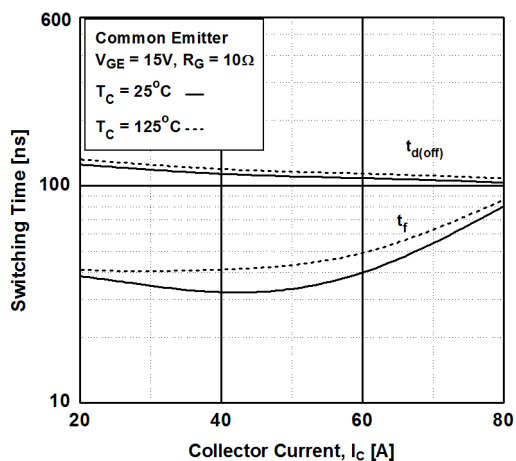


Figure 16. Switching Loss vs. Gate Resistance

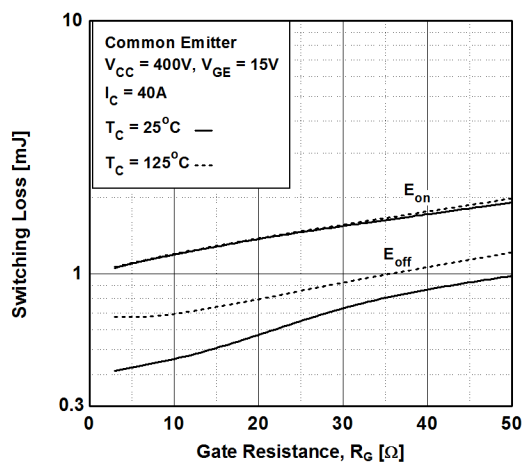


Figure 17. Switching Loss vs. Collector Current

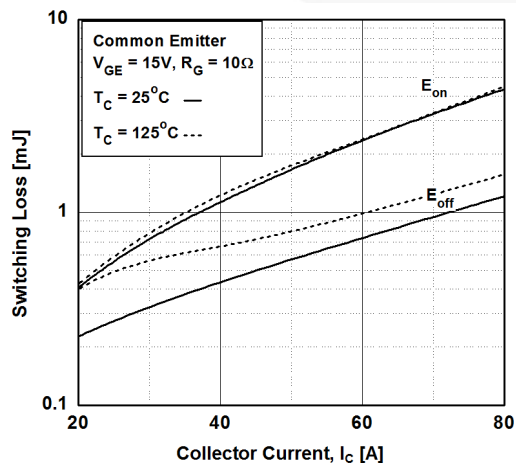
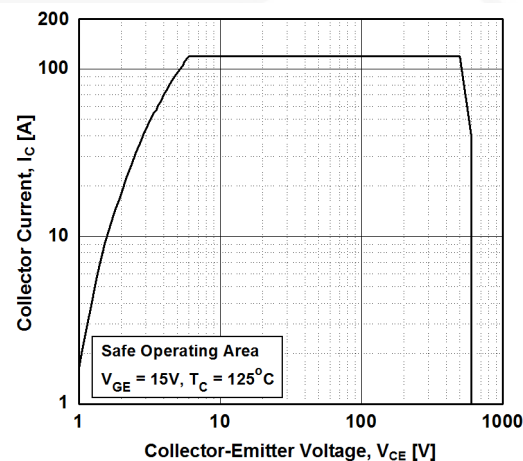


Figure 18. Turn off Switching SOA Characteristics



## Typical Performance Characteristics

Figure 19. Forward Characteristics

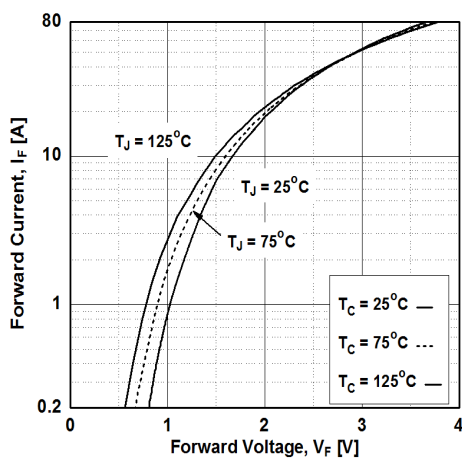


Figure 20. Reverse Current

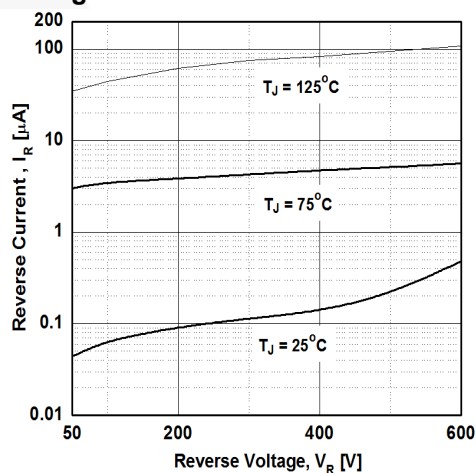


Figure 21. Stored Charge

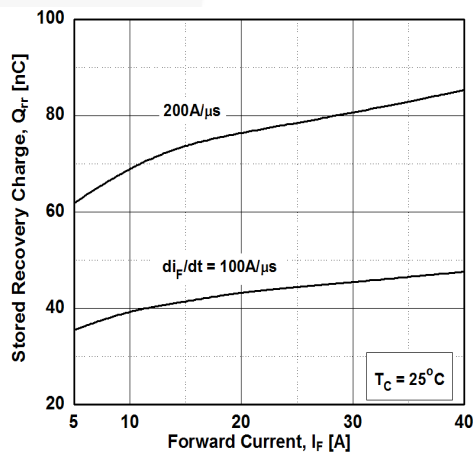


Figure 22. Reverse Recovery Time

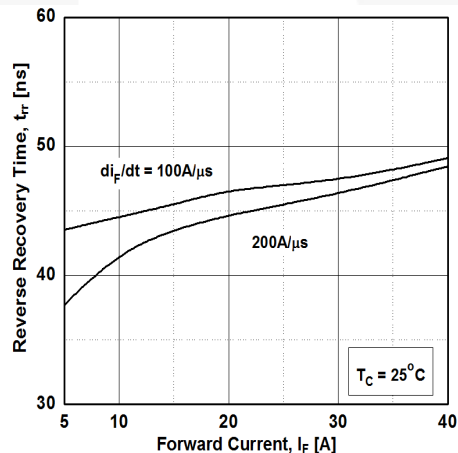
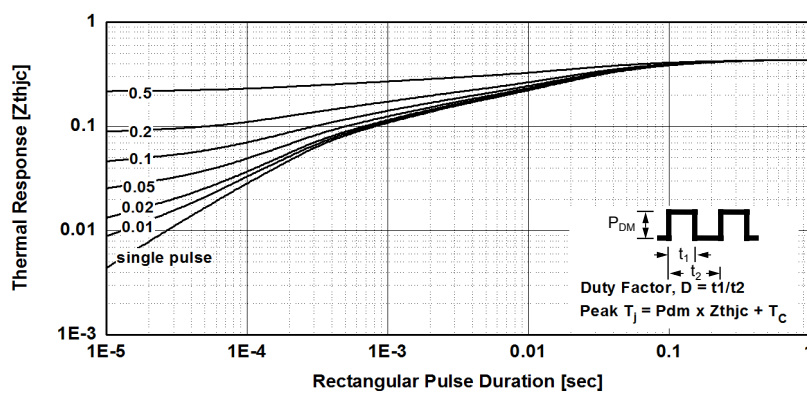
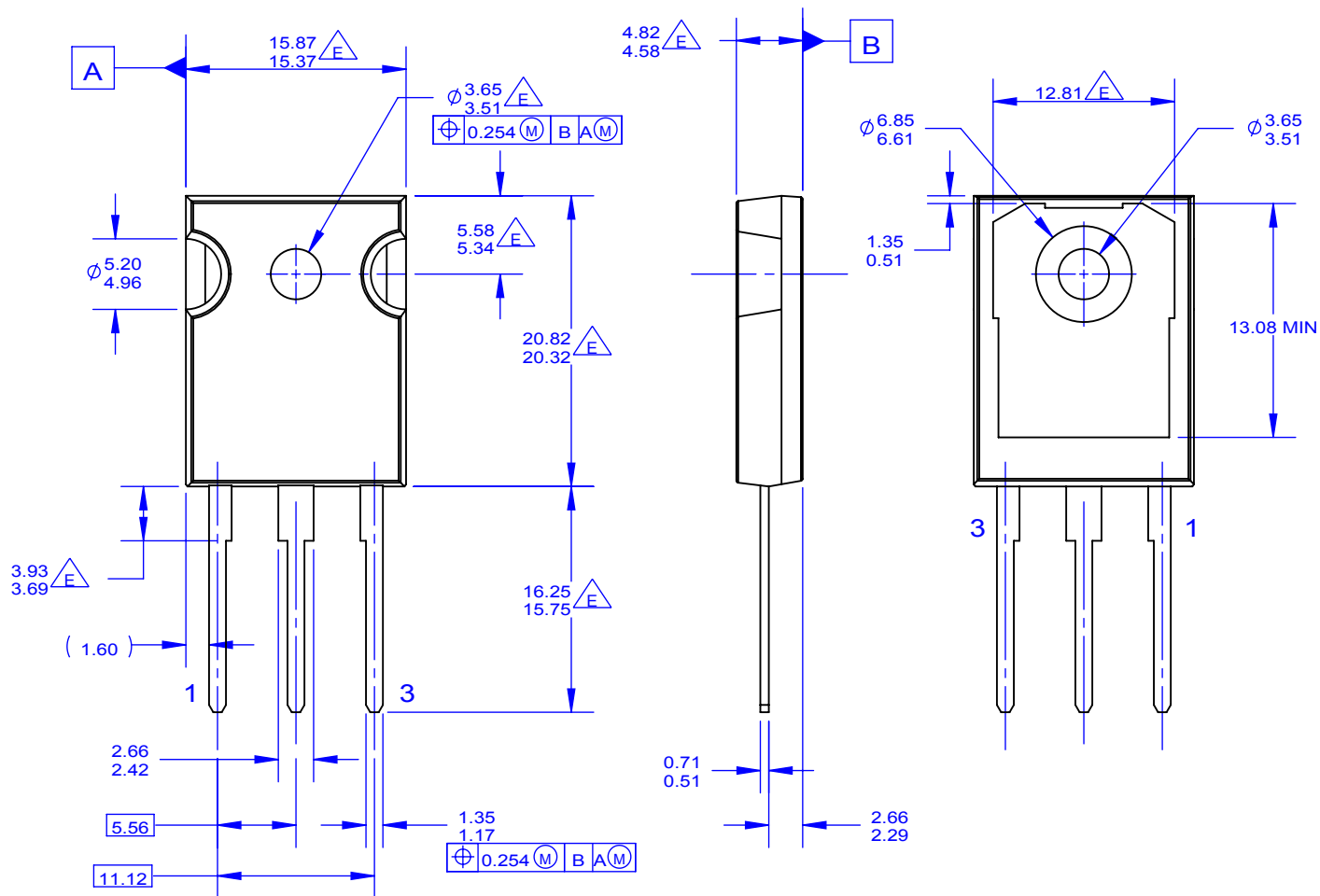


Figure 23. Transient Thermal Impedance of IGBT





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