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May 2017

# FGY120T65SPD\_F085 650V, 120A Field Stop Trench IGBT With Soft Fast Recovery Diode

## Features

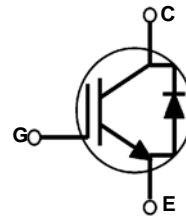
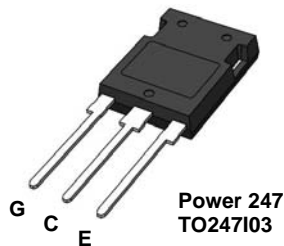
- AEC-Q101 Qualified
- Very low saturation voltage :  $V_{CE(sat)} = 1.5 \text{ V(Typ.)}$  @  $I_C = 120 \text{ A}$
- Maximum junction temperature :  $T_J = 175 \text{ }^\circ\text{C}$
- Positive temperature Co-efficient
- Tight parameter distribution
- High input impedance
- 100% of the parts are dynamically tested
- Short circuit ruggedness >  $6 \mu\text{s}$  @  $25 \text{ }^\circ\text{C}$
- Copacked with soft, fast recovery Extremefast diode

## Benefits

- Very Low conduction and switching losses for a high efficiency operation in various applications
- Rugged transient reliability
- Outstanding parallel operation performance with balance current sharing
- Low EMI

## Applications

- Traction inverter for HEV/EV
- Auxiliary DC/AC converter
- Motor drives
- Other power-train applications requiring high power switch



## Absolute Maximum Ratings

| Symbol        | Description   | Ratings                              | Units            |
|---------------|---|--------------------------------------|------------------|
| $V_{CES}$     | Collector to Emitter Voltage  | 650                                  | V                |
| $V_{GES}$     | Gate to Emitter Voltage   | $\pm 20$                             | V                |
|               | Transient Gate to Emitter Voltage                                       | $\pm 30$                             | V                |
| $I_C$         | Collector Current (Note1)   | @ $T_C = 25 \text{ }^\circ\text{C}$  | 240              |
|               | Collector Current   | @ $T_C = 100 \text{ }^\circ\text{C}$ | 220              |
| $I_{Nominal}$ | Nominal Current   | 120                                  | A                |
| $I_{CM}$      | Pulsed Collector Current  | 378                                  | A                |
| $I_F$         | Diode Forward Current (Note1)   | @ $T_C = 25 \text{ }^\circ\text{C}$  | 240              |
|               | Diode Forward Current   | @ $T_C = 100 \text{ }^\circ\text{C}$ | 188              |
| $P_D$         | Maximum Power Dissipation   | @ $T_C = 25 \text{ }^\circ\text{C}$  | 882              |
|               | Maximum Power Dissipation   | @ $T_C = 100 \text{ }^\circ\text{C}$ | 441              |
| SCWT          | Short Circuit Withstand Time  | @ $T_C = 25 \text{ }^\circ\text{C}$  | 6                |
| dV/dt         | Voltage Transient Ruggedness (Note2)                                    | 10                                   | V/ns             |
| $T_J$         | 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: Limited by bondwire

2:  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $I_{CE} = 378 \text{ A}$ , Inductive Load

## Thermal Characteristics

| Symbol                  | Parameter                               | Typ. | Max. | Units                       |
|-------------------------|---|------|------|-----------------------------|
| $R_{\theta JC}$ (IGBT)  | Thermal Resistance, Junction to Case    | -    | 0.17 | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta JC}$ (Diode) | Thermal Resistance, Junction to Case    | -    | 0.32 | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta JA}$         | Thermal Resistance, Junction to Ambient | -    | 40   | $^{\circ}\text{C}/\text{W}$ |

## Package Marking and Ordering Information

| Device Marking | Device            | Package | Pacing Type | Qty per Tube |
|----------------|-------------------|---------|-------------|--------------|
| FGY120T65SPD   | FGY120T65SPD_F085 | TP-247  | Tube        | 30ea         |

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

| Symbol                           | Parameter                                    | Test Conditions   | Min. | Typ. | Max.      | Units                       |
|----------------------------------|--|---|------|------|-----------|-----------------------------|
| <b>Off Characteristics</b>       |  |   |      |      |           |                             |
| $BV_{CES}$                       | Collector to Emitter Breakdown Voltage       | $V_{GE} = 0\text{V}, I_C = 1\text{mA}$  | 650  | -    | -         | V                           |
| $\Delta BV_{CES} / \Delta T_J$   | Temperature Coefficient of Breakdown Voltage | $V_{GE} = 0\text{V}, I_C = 1\text{mA}$  | -    | 0.6  | -         | $\text{V}/^{\circ}\text{C}$ |
| $I_{CES}$                        | Collector Cut-Off Current                    | $V_{CE} = V_{CES}, V_{GE} = 0\text{V}$  | -    | -    | 40        | $\mu\text{A}$               |
| $I_{GES}$                        | G-E Leakage Current                          | $V_{GE} = V_{GES}, V_{CE} = 0\text{V}$  | -    | -    | $\pm 250$ | nA                          |
| <b>On Characteristics</b>        |  |   |      |      |           |                             |
| $V_{GE(th)}$                     | G-E Threshold Voltage                        | $I_C = 120\text{mA}, V_{CE} = V_{GE}$   | 4.2  | 5.4  | 6.2       | V                           |
| $V_{CE(sat)}$                    | Collector to Emitter Saturation Voltage      | $I_C = 120\text{A}, V_{GE} = 15\text{V}$  | -    | 1.5  | 1.85      | V                           |
|                                  |  | $I_C = 120\text{A}, V_{GE} = 15\text{V}, T_J = 175^{\circ}\text{C}$   | -    | 1.8  | -         | V                           |
| <b>Dynamic Characteristics</b>   |  |   |      |      |           |                             |
| $C_{ies}$                        | Input Capacitance                            | $V_{CE} = 30\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$  | -    | 6810 | -         | pF                          |
| $C_{oes}$                        | Output Capacitance                           |   | -    | 440  | -         | pF                          |
| $C_{res}$                        | Reverse Transfer Capacitance                 |   | -    | 50   | -         | pF                          |
| $R_G$                            | Internal Gate Resistance                     | $f = 1\text{MHz}$   | -    | 3    | -         | $\Omega$                    |
| <b>Switching Characteristics</b> |  |   |      |      |           |                             |
| $T_{d(on)}$                      | Turn-On Delay Time                           | $V_{CC} = 400\text{V}, I_C = 120\text{A}, R_G = 5\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_J = 25^{\circ}\text{C}$  | -    | 53   | -         | ns                          |
| $T_r$                            | Rise Time                                    |   | -    | 134  | -         | ns                          |
| $T_{d(off)}$                     | Turn-Off Delay Time                          |   | -    | 102  | -         | ns                          |
| $T_f$                            | Fall Time                                    |   | -    | 115  | -         | ns                          |
| $E_{on}$                         | Turn-On Switching Loss                       |   | -    | 6.8  | -         | mJ                          |
| $E_{off}$                        | Turn-Off Switching Loss                      |   | -    | 3.5  | -         | mJ                          |
| $E_{ts}$                         | Total Switching Loss                         |   | -    | 10.3 | -         | mJ                          |
| $T_{d(on)}$                      | Turn-On Delay Time                           | $V_{CC} = 400\text{V}, I_C = 120\text{A}, R_G = 5\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_J = 175^{\circ}\text{C}$ | -    | 50   | -         | ns                          |
| $T_r$                            | Rise Time                                    |   | -    | 133  | -         | ns                          |
| $T_{d(off)}$                     | Turn-Off Delay Time                          |   | -    | 109  | -         | ns                          |
| $T_f$                            | Fall Time                                    |   | -    | 138  | -         | ns                          |
| $E_{on}$                         | Turn-On Switching Loss                       |   | -    | 9.8  | -         | mJ                          |
| $E_{off}$                        | Turn-Off Switching Loss                      |   | -    | 4.0  | -         | mJ                          |
| $E_{ts}$                         | Total Switching Loss                         |   | -    | 13.8 | -         | mJ                          |

### Electrical Characteristics of the IGBT (Continued)

| Symbol   | Parameter                | Test Conditions                                | Min. | Typ. | Max | Units |
|----------|--------------------------|--|------|------|-----|-------|
| $Q_g$    | Total Gate Charge        | $V_{CE} = 400V, I_C = 120A,$<br>$V_{GE} = 15V$ | -    | 162  | 243 | nC    |
| $Q_{ge}$ | Gate to Emitter Charge   |  | -    | 49   | -   | nC    |
| $Q_{gc}$ | Gate to Collector Charge |  | -    | 47   | -   | nC    |

### Electrical Characteristics of the Diode $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted

| Symbol    | Parameter                     | Test Conditions   | Min.                              | Typ. | Max  | Units |         |
|-----------|-------------------------------|---|-----------------------------------|------|------|-------|---------|
| $V_{FM}$  | Diode Forward Voltage         | $I_F = 120A$  | $T_J = 25\text{ }^\circ\text{C}$  | -    | 1.3  | 1.6   | V       |
|           |                               |   | $T_J = 175\text{ }^\circ\text{C}$ | -    | 1.2  | -     |         |
| $E_{rec}$ | Reverse Recovery Energy       | $V_{CE} = 400V, I_F = 120A,$<br>$di_F/dt = 1000A/\mu s$ | $T_J = 25\text{ }^\circ\text{C}$  | -    | 450  | -     | $\mu J$ |
|           |                               |   | $T_J = 175\text{ }^\circ\text{C}$ | -    | 3000 | -     |         |
| $T_{rr}$  | Diode Reverse Recovery Time   |   | $T_J = 25\text{ }^\circ\text{C}$  | -    | 123  | -     | ns      |
|           |                               |   | $T_J = 175\text{ }^\circ\text{C}$ | -    | 240  | -     |         |
| $Q_{rr}$  | Diode Reverse Recovery Charge |   | $T_J = 25\text{ }^\circ\text{C}$  | -    | 2.8  | -     | $\mu C$ |
|           |                               |   | $T_J = 175\text{ }^\circ\text{C}$ | -    | 12.2 | -     |         |

## Typical Performance Characteristics

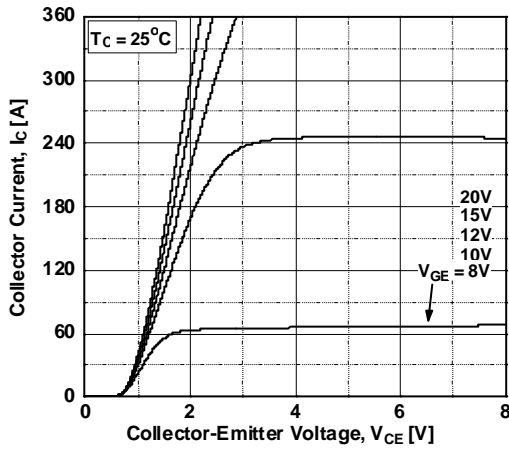


Figure 1. Typical Output Characteristics

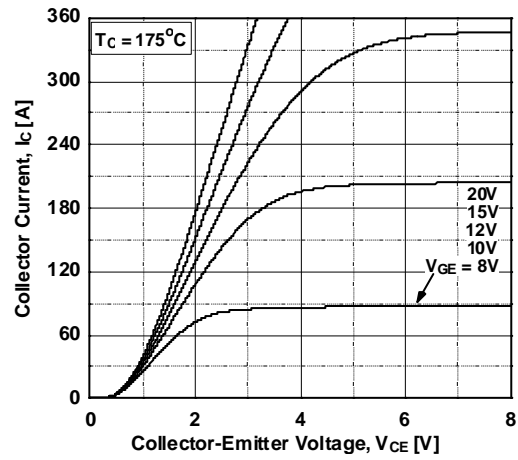


Figure 2. Typical Output Characteristics

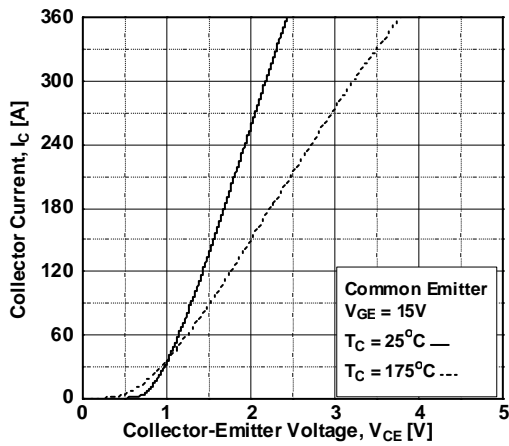


Figure 3. Typical Saturation Voltage Characteristics

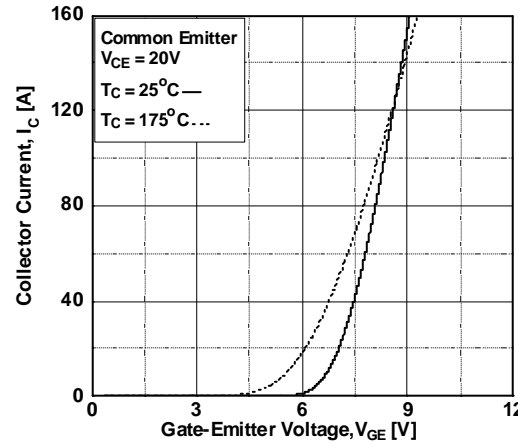


Figure 4. Transfer Characteristics

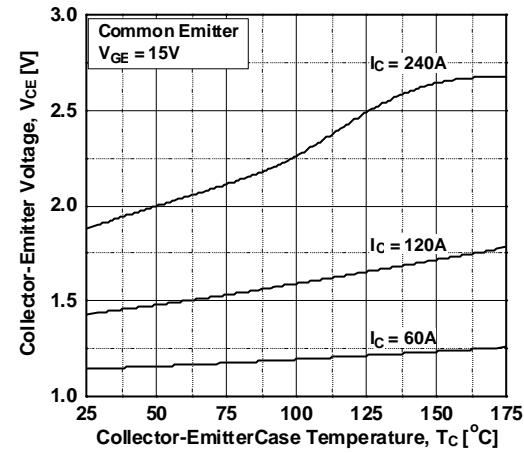


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

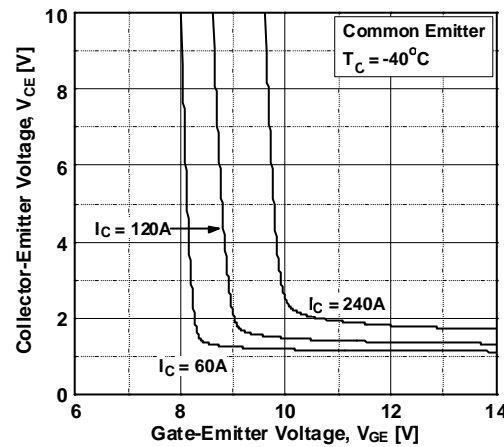


Figure 6. Saturation Voltage vs.  $V_{GE}$

## Typical Performance Characteristics

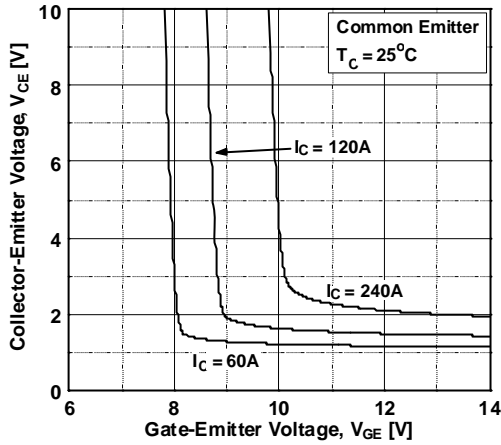


Figure 7. Saturation Voltage vs.  $V_{GE}$

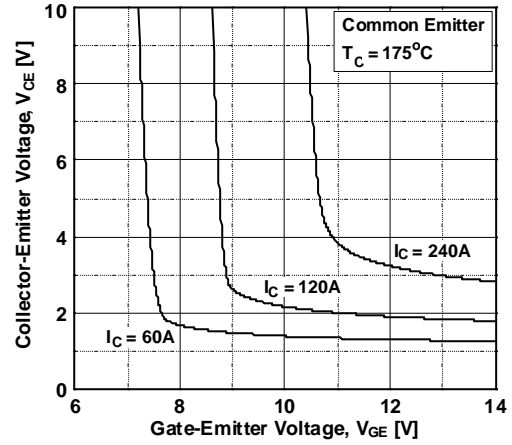


Figure 8. Saturation Voltage vs.  $V_{GE}$

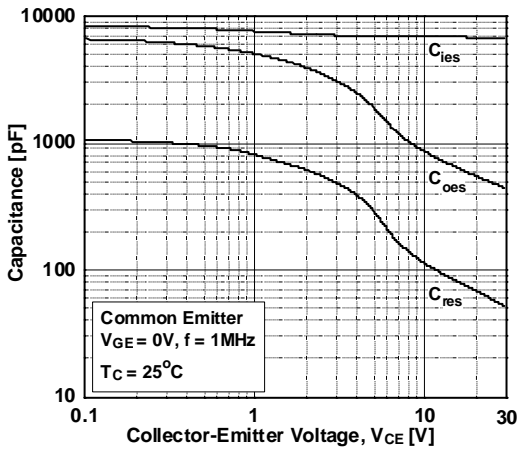


Figure 9. Capacitance Characteristics

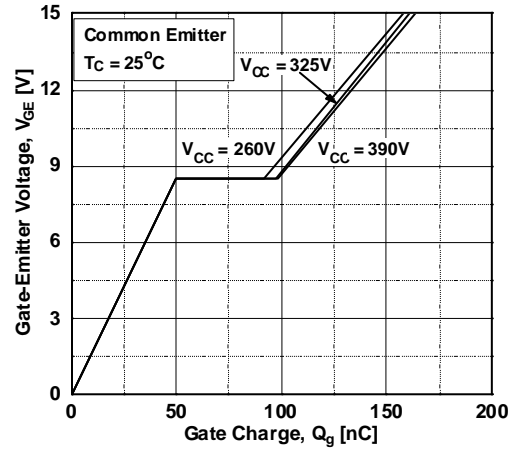


Figure 10. Gate charge Characteristics

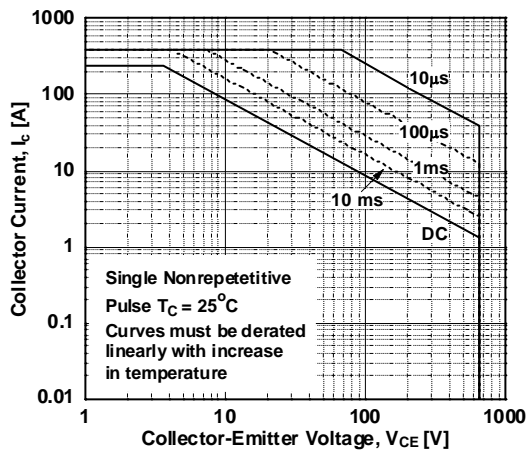


Figure 11. SOA Characteristics

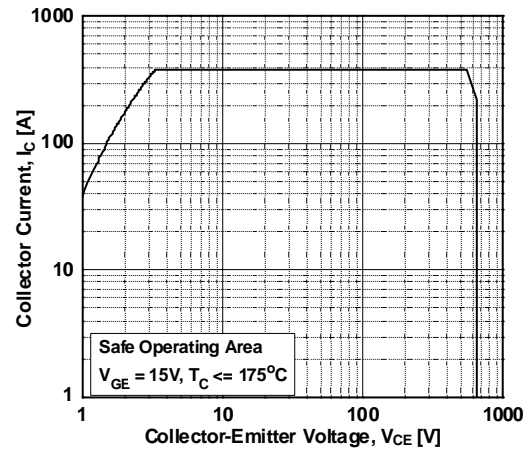


Figure 12. Turn off Switching SOA Characteristics

## Typical Performance Characteristics

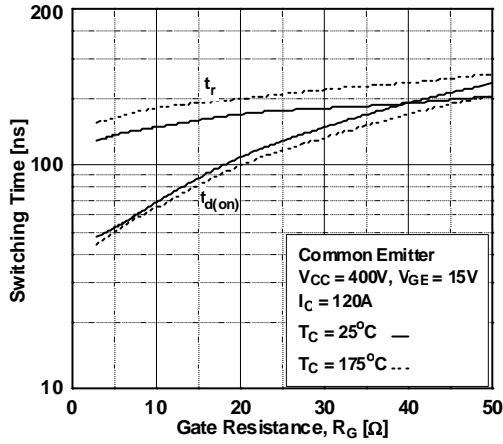


Figure 13. Turn-on Characteristics vs. Gate Resistance

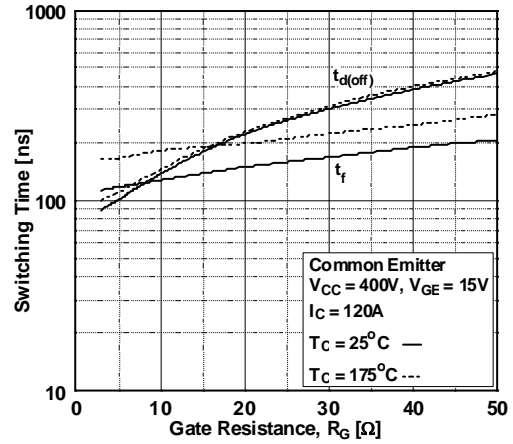


Figure 14. Turn-off Characteristics vs. Gate Resistance

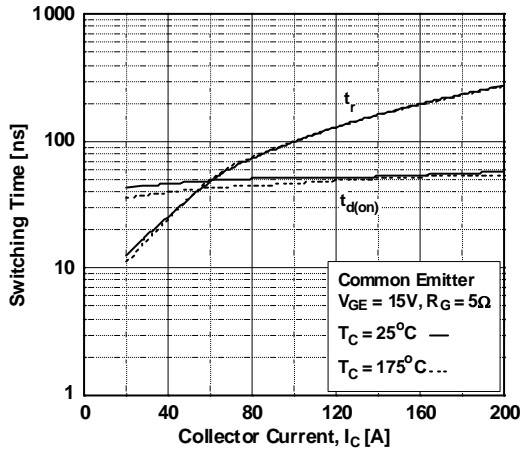


Figure 15. Turn-on Characteristics vs. Collector Current

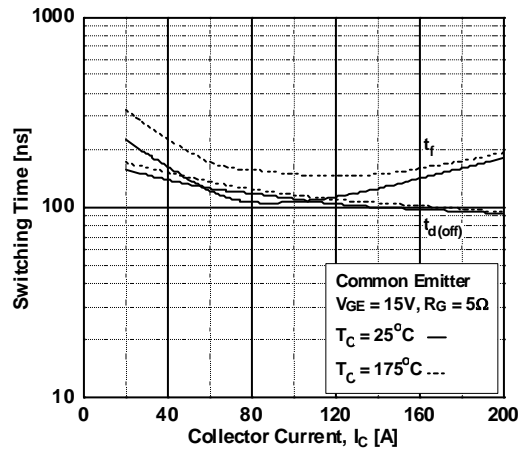


Figure 16. Turn-off Characteristics vs. Collector Current

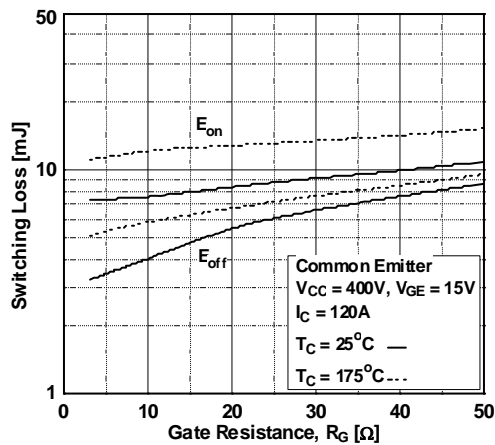


Figure 17. Switching Loss vs Gate Resistance

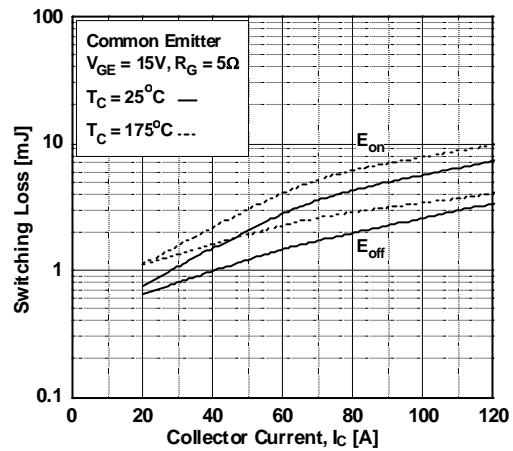


Figure 18. Switching Loss vs Collector Current

## Typical Performance Characteristics

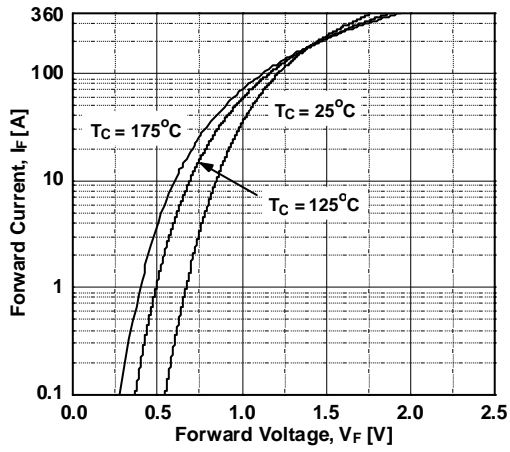


Figure 19. Forward Characteristics

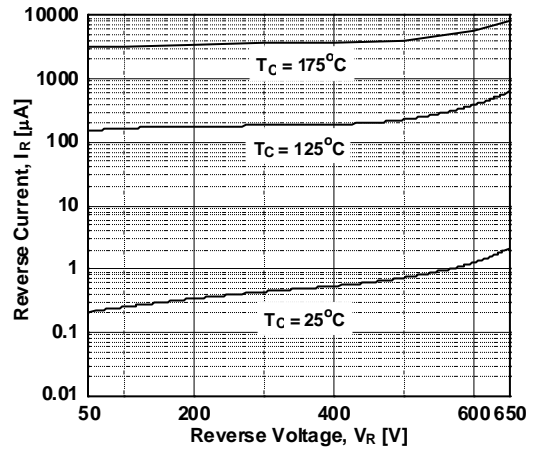


Figure 20. Reverse Current

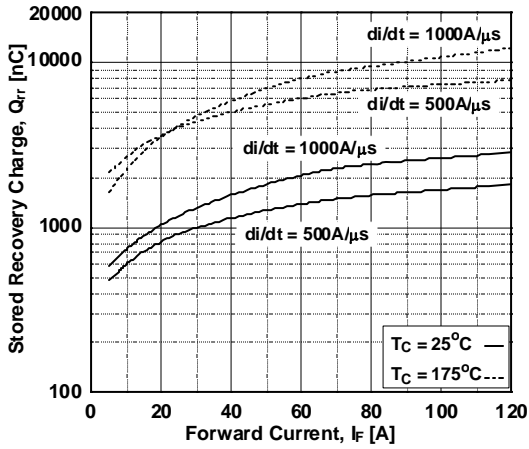


Figure 21. Stored Charge

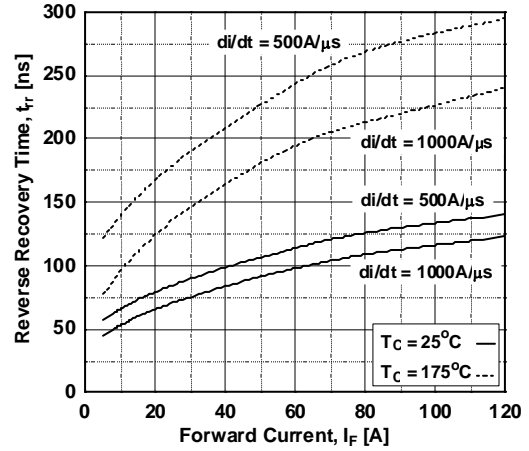


Figure 22. Reverse Recovery Time

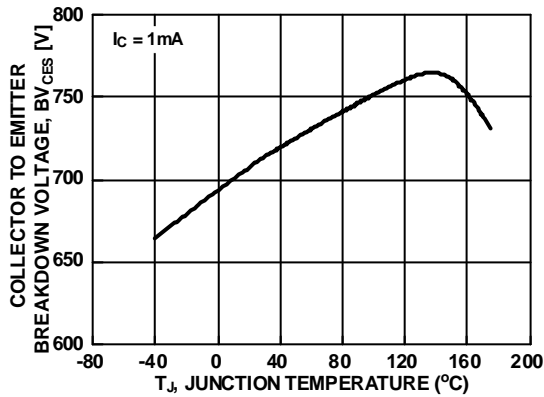
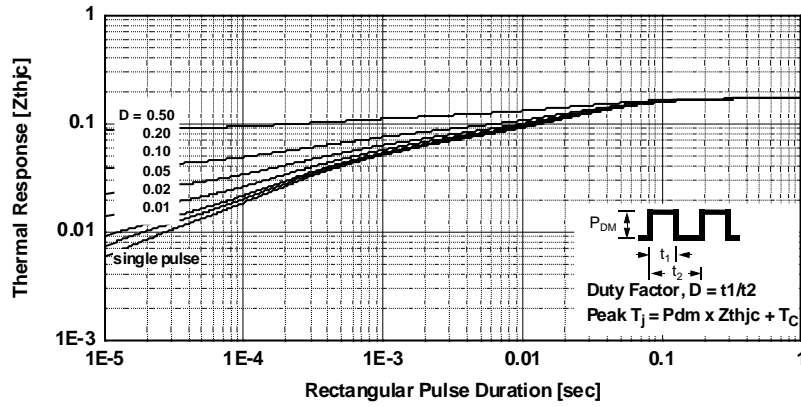


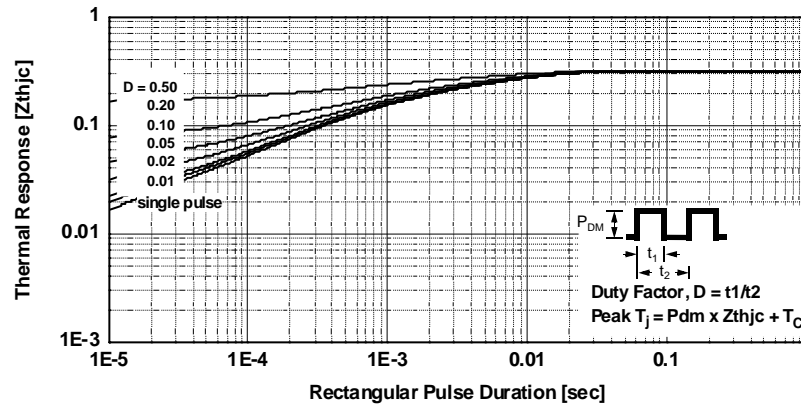
Figure 23. Collector to Emitter Breakdown Voltage vs. Junction Temperature



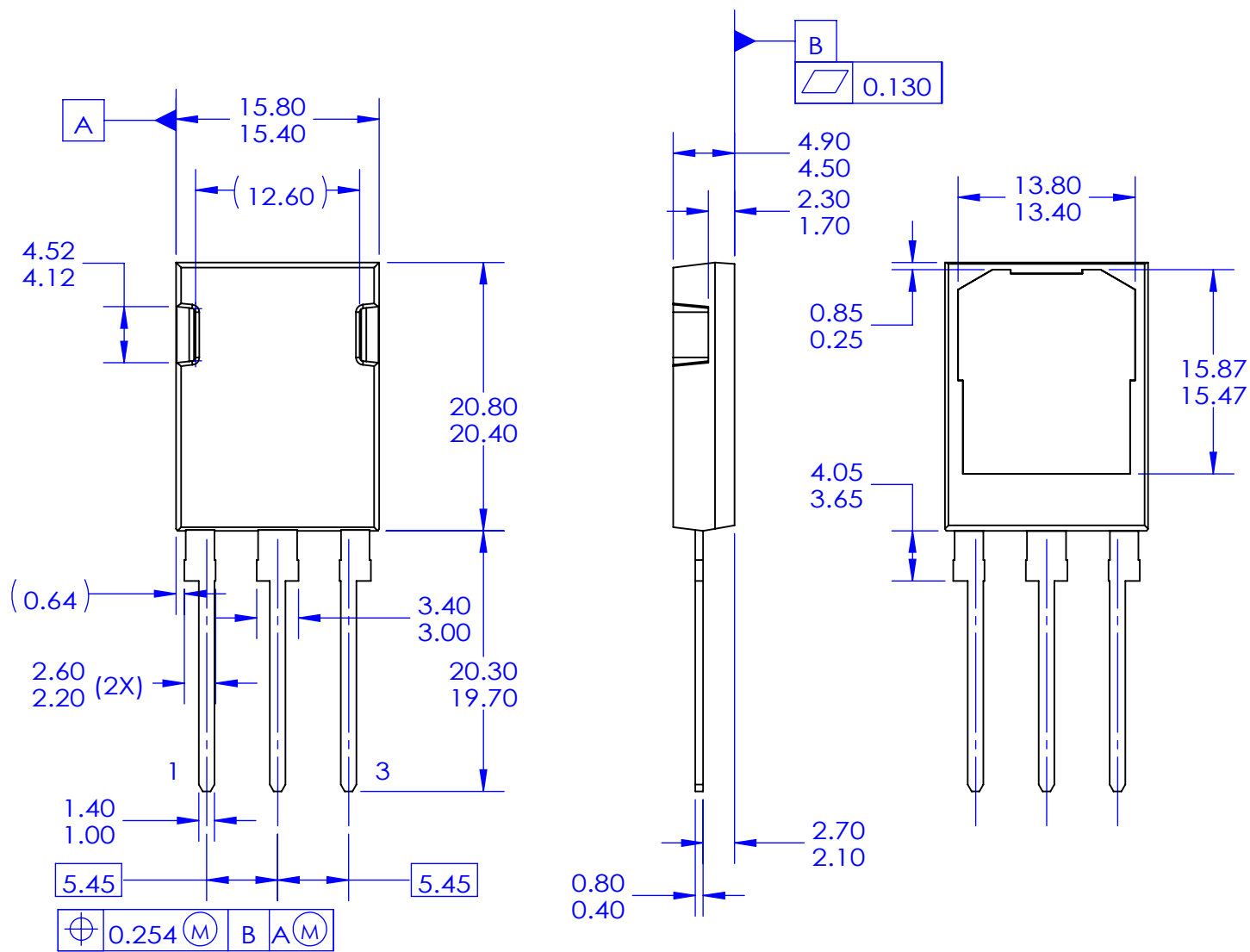
### Typical Performance Characteristics



**Figure 24. Transient Thermal Impedance of IGBT**



**Figure 25. Transient Thermal Impedance of Diode**



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