

## VBMB16I10 Datasheet

### 600V Trench and Fieldstop IGBT

| PRODUCT SUMMARY   |                               |                                |
|-------------------|-------------------------------|--------------------------------|
| $V_{CE}$ (V)      | 600                           |                                |
| $I_C$ (A)         | 20 ( $T_C=25^\circ\text{C}$ ) | 10 ( $T_C=100^\circ\text{C}$ ) |
| $V_{CE(sat)}$ (V) | 1.7                           |                                |
| $I_{CM}$ (A)      | 30                            |                                |

#### FEATURES

- Very Low  $V_{CEsat}$
- Low turn-off losses
- High speed switching
- Maximum junction temperature  $175^\circ\text{C}$
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)



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**FREE**

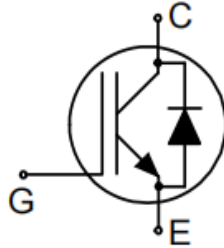
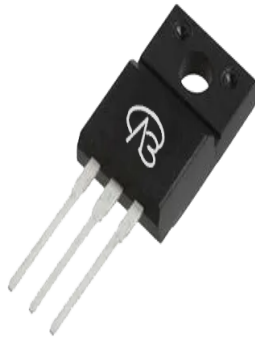
#### APPLICATIONS

- Telecommunications
  - Server and telecom power supplies
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Consumer and computing
  - ATX power supplies
- Industrial
  - Welding
  - Battery chargers
- Renewable energy
  - Solar (PV inverters)
- Switch mode power supplies (SMPS)

#### Package pin definition

- Pin1 G - Gate
- Pin2 C & backside - Collector
- Pin3 E - Emitter

TO-220F



Top View

| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                         |                         |                                   |             |      |
|---------------------------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| PARAMETER                                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
| Collector-Emitter Voltage                                                 |                         |                         | V <sub>CE</sub>                   | 600         | V    |
| Gate-Emitter Voltage                                                      |                         |                         | V <sub>GE</sub>                   | ±30         |      |
| Continuous Collector Current (T <sub>J</sub> = 150 °C)                    | V <sub>GE</sub> at 15 V | T <sub>C</sub> = 25 °C  | I <sub>C</sub>                    | 20          | A    |
|                                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 10          |      |
| Pulsed Collector Current <sup>a</sup>                                     |                         |                         | I <sub>CM</sub>                   | 30          |      |
| Diode Forward Current <sup>b</sup>                                        |                         |                         | I <sub>F</sub>                    | 10          | A    |
| Maximum Power Dissipation                                                 |                         | T <sub>C</sub> = 25 °C  | P <sub>D</sub>                    | 44          | W    |
|                                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 12.5        | W    |
| Operating Junction and Storage Temperature Range                          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +175 | °C   |
| Short Circuit Withstand Time <sup>TC=150°C</sup>                          | VGE= 15V, VCE≤ 400V     |                         | tsc                               | 3           | μs   |
| Short Circuit Withstand Time <sup>TC=100°C</sup>                          | VGE= 15V, VCE≤ 330V     |                         |                                   | 5           |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>                 | for 10 s                |                         |                                   | 260         | °C   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- Current limited by maximum junction temperature.
- 1.6 mm from case.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                   | SYMBOL     | TYP. | MAX. | UNIT |
|-----------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient | $R_{thJA}$ | -    | 78   | °C/W |
| Maximum Junction-to-Case    | $R_{thJC}$ | -    | 3.6  |      |

**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                 | SYMBOL               | TEST CONDITIONS                                                                                         |                                               | MIN.       | TYP.   | MAX.   | UNIT |
|-------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------|--------|--------|------|
| Static                                    |                      |                                                                                                         |                                               |            |        |        |      |
| Collector-Emitter Breakdown Voltage       | BV <sub>CE</sub>     | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA<br>V <sub>GE</sub> = 0 V, I <sub>C</sub> = 1 mA          |                                               | 600<br>600 | -<br>- | -<br>- | V    |
| Gate-Source Threshold Voltage (N)         | V <sub>GE(th)</sub>  | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>D</sub> = 250 μA                                             |                                               | 4          | 5      | 6      | V    |
| Zero Gate Voltage Collector Current       | I <sub>CES</sub>     | V <sub>CE</sub> = 600 V,V <sub>GE</sub> = 0 V,T <sub>J</sub> = 25 °C                                    |                                               | -          | 1      | 20     | μA   |
|                                           |                      | V <sub>CE</sub> = 600 V,V <sub>GE</sub> = 0 V,T <sub>J</sub> = 150 °C                                   |                                               | -          | 1000   | -      | μA   |
| Gate-Emitter Leakage Current              | I <sub>GES</sub>     | V <sub>CE</sub> = 0 V, V <sub>GS</sub> = ± 2 0 V                                                        |                                               | -          | -      | 100    | nA   |
| Collector-Emitter Saturation Voltage      | V <sub>CE(sat)</sub> | V <sub>GE</sub> = 7 V                                                                                   | I <sub>C</sub> = 7 A                          | -          | 1.7    | 2.1    | V    |
| Forward Transconductance                  | g <sub>fs</sub>      | V <sub>CE</sub> = 20 V, I <sub>C</sub> = 7 A                                                            |                                               | -          | 15     | -      | S    |
| Dynamic                                   |                      |                                                                                                         |                                               |            |        |        |      |
| Input Capacitance                         | C <sub>ies</sub>     | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 25 V,<br>f = 500 KHz                                           |                                               | -          | 1300   | -      | pF   |
| Output Capacitance                        | C <sub>oes</sub>     |                                                                                                         |                                               | -          | 36     | -      |      |
| Reverse Transfer Capacitance              | C <sub>res</sub>     |                                                                                                         |                                               | -          | 2 6    | -      |      |
| Turn-on Energy                            | E <sub>on</sub>      | V <sub>CE</sub> = 400 V , V <sub>GE</sub> = 0 /15V,<br>I <sub>C</sub> = 7 A, R <sub>g</sub> = 10Ω       |                                               | -          | 0.44   | -      | nJ   |
| Turn-off Energy                           | E <sub>off</sub>     |                                                                                                         |                                               | -          | 0.15   | -      |      |
| Total Gate Charge                         | Q <sub>g</sub>       | V <sub>GE</sub> = 7 V                                                                                   | I <sub>C</sub> = 7 A, V <sub>CE</sub> = 400 V | -          | 6 2    | -      | nC   |
| Gate-Emitter Charge                       | Q <sub>ge</sub>      |                                                                                                         |                                               | -          | 13     | -      |      |
| Gate to Collector Charge                  | Q <sub>gc</sub>      |                                                                                                         |                                               | -          | 22     | -      |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>   | V <sub>CE</sub> = 400 V , V <sub>GE</sub> = 0 /15V,<br>I <sub>C</sub> = 7 A, R <sub>g</sub> = 10Ω       |                                               | -          | 19     | -      | ns   |
| Rise Time                                 | t <sub>r</sub>       |                                                                                                         |                                               | -          | 26     | -      |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>  |                                                                                                         |                                               | -          | 115    | -      |      |
| Fall Time                                 | t <sub>f</sub>       |                                                                                                         |                                               | -          | 42     | -      |      |
| Internal emitter inductance measured 5 mm | L <sub>E</sub>       |                                                                                                         |                                               | -          | 13     | -      | nH   |
| Diode Characteristics                     |                      |                                                                                                         |                                               |            |        |        |      |
| Diode Forward Current                     | I <sub>F</sub>       | IGBT symbol showing the<br>integral reverse junction diode                                              |                                               | -          | -      | 10     | A    |
| Pulsed Diode Forward Current              | I <sub>FM</sub>      |                                                                                                         |                                               | -          | -      | 30     |      |
| Diode Forward Voltage                     | V <sub>F</sub>       | I <sub>F</sub> = 7 A                                                                                    |                                               | -          | 1.72   | 2.0    | V    |
| Reverse Recovery Time                     | t <sub>rr</sub>      | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 7 A,<br>dI <sub>F</sub> /dt = 200 A/μs, V <sub>R</sub> = 400 V |                                               | -          | 74     | -      | ns   |
| Reverse Recovery Charge                   | Q <sub>rr</sub>      |                                                                                                         |                                               | -          | 0.38   | -      | μC   |
| Reverse Recovery Current                  | I <sub>RRM</sub>     |                                                                                                         |                                               | -          | 9      | -      | A    |

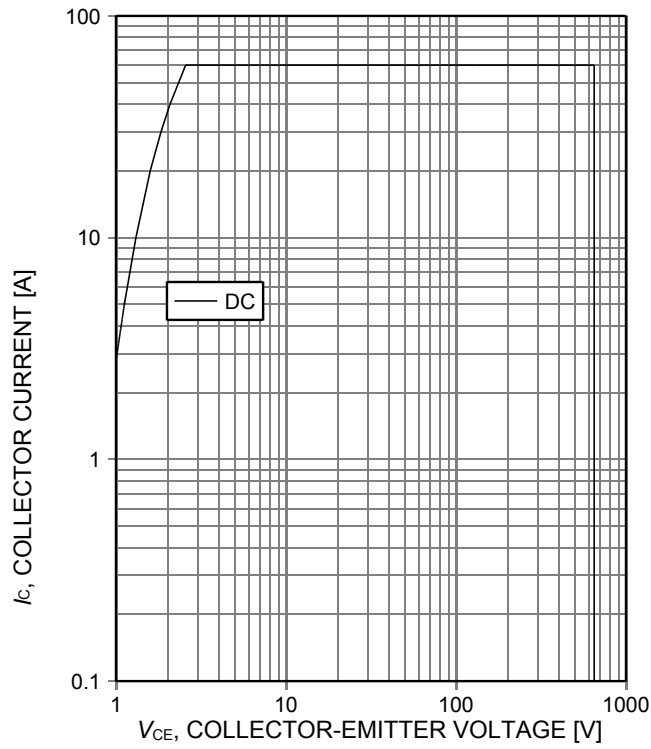


Figure 1. **Forward bias safe operating area**  
 $(D=0, T_C=25^{\circ}\text{C}, T_{vj}\leq 175^{\circ}\text{C}; V_{GE}=15\text{V}.$   
 Recommended use at  $V_{GE}\geq 7.5\text{V}$ )

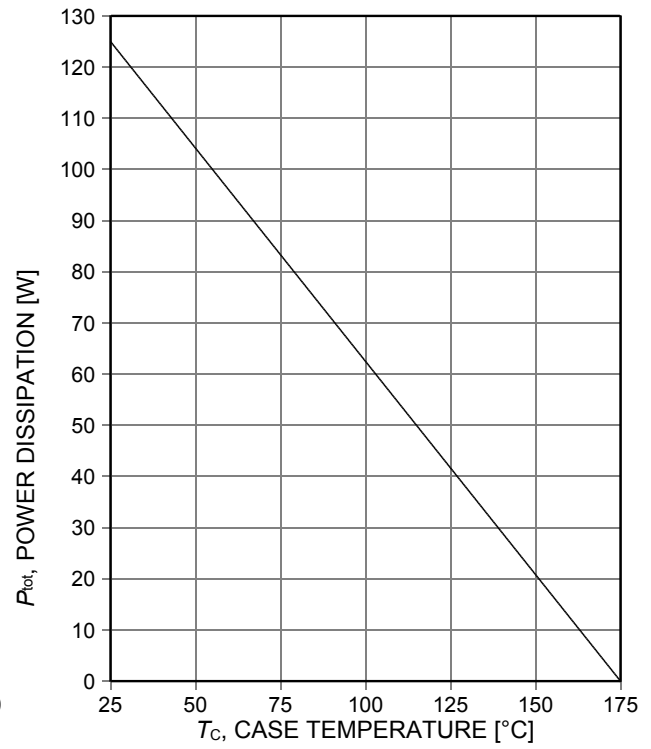


Figure 2. **Power dissipation as a function of case temperature**  
 $(T_{vj}\leq 175^{\circ}\text{C})$

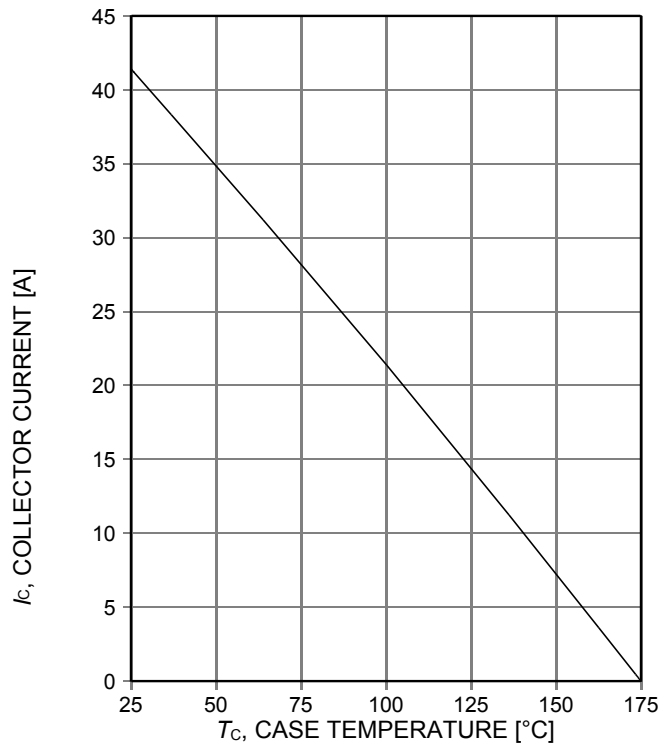


Figure 3. **Collector current as a function of case temperature**

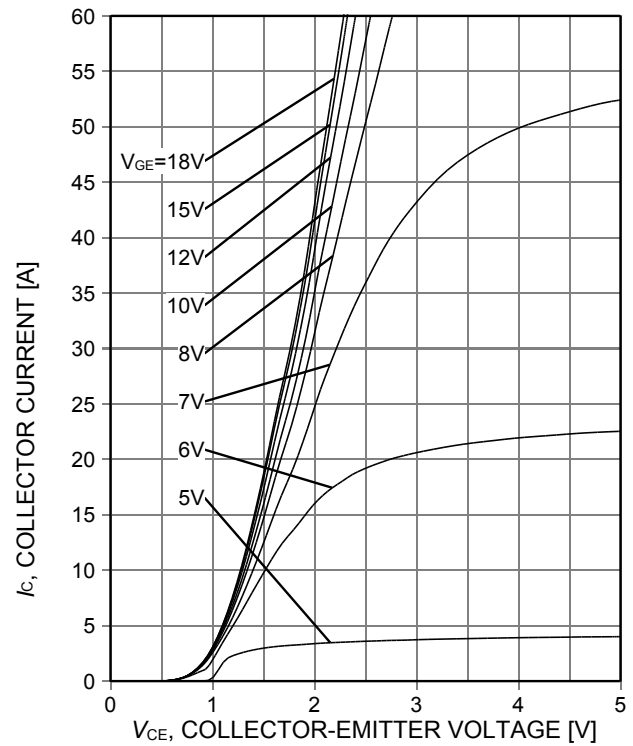


Figure 4. **Typical output characteristic**

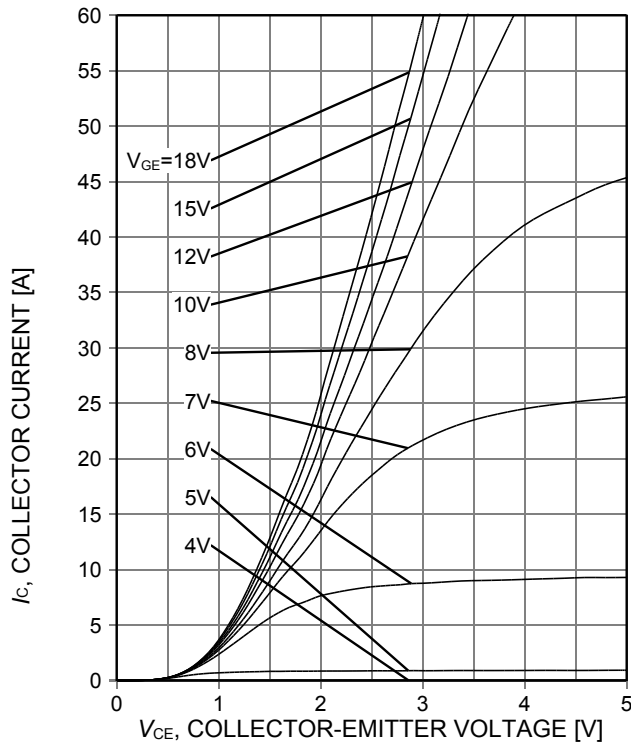


Figure 5. Typical output characteristic  
( $T_{vj}=150^{\circ}\text{C}$ )

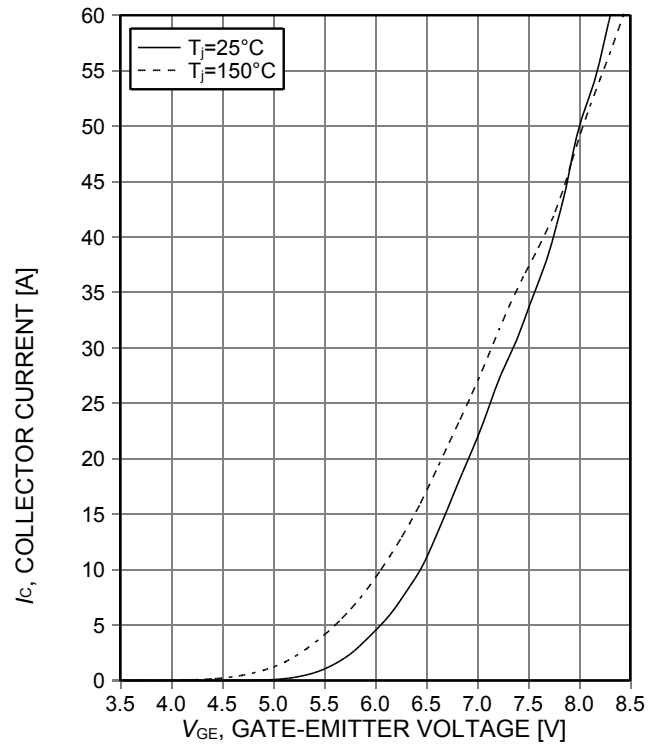


Figure 6. Typical transfer characteristic  
( $V_{ce}=20\text{V}$ )

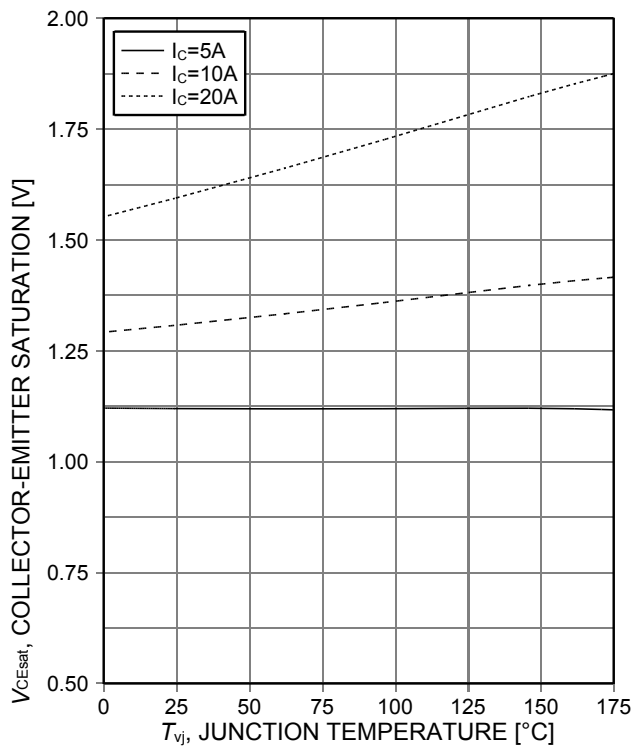


Figure 7. Typical collector-emitter saturation voltage as  
a function of junction temperature

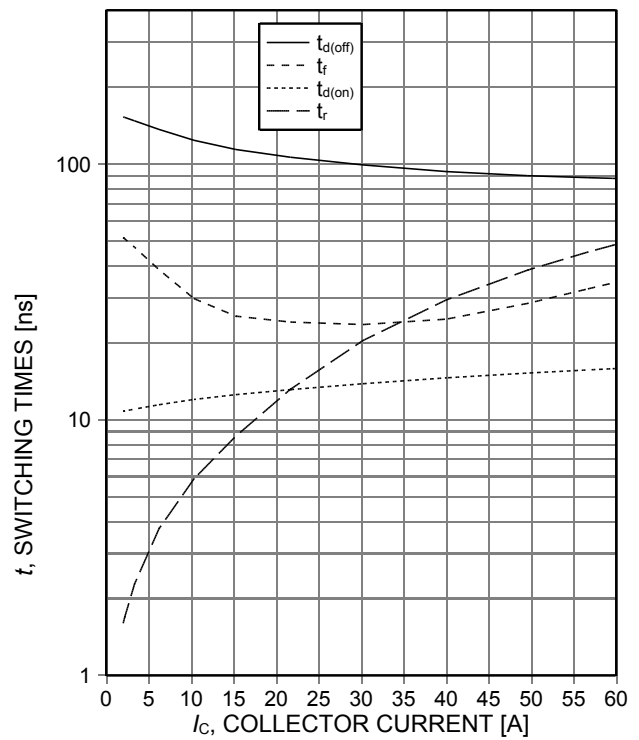


Figure 8. Typical switching times as a function of  
collector current

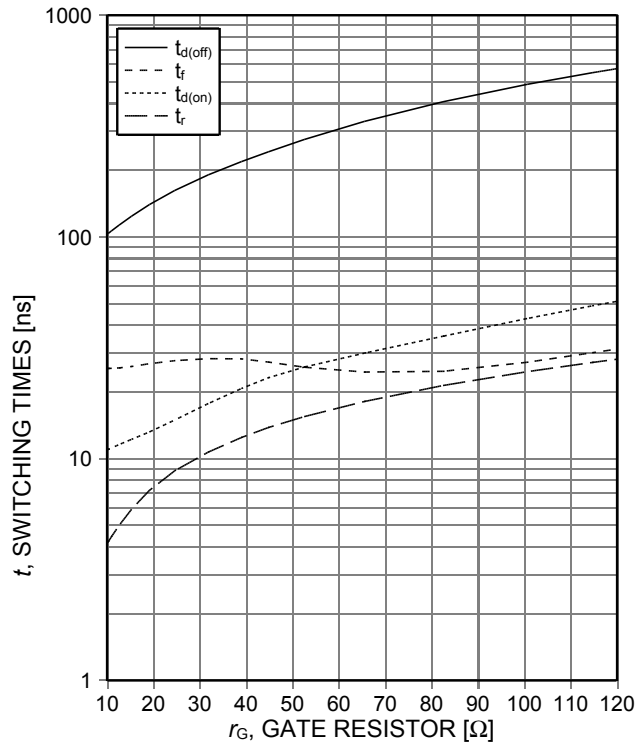


Figure 9. Typical switching times as a function of gate resistor

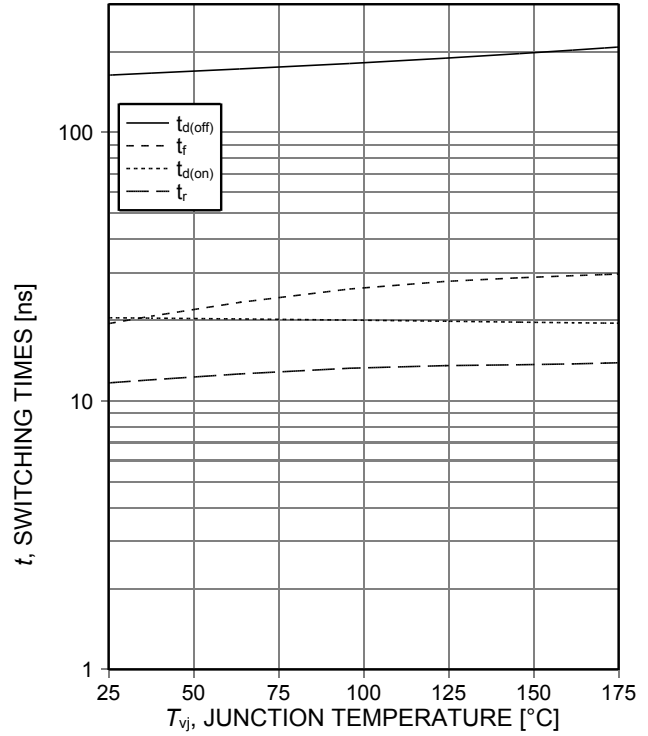


Figure 10. Typical switching times as a function of junction temperature

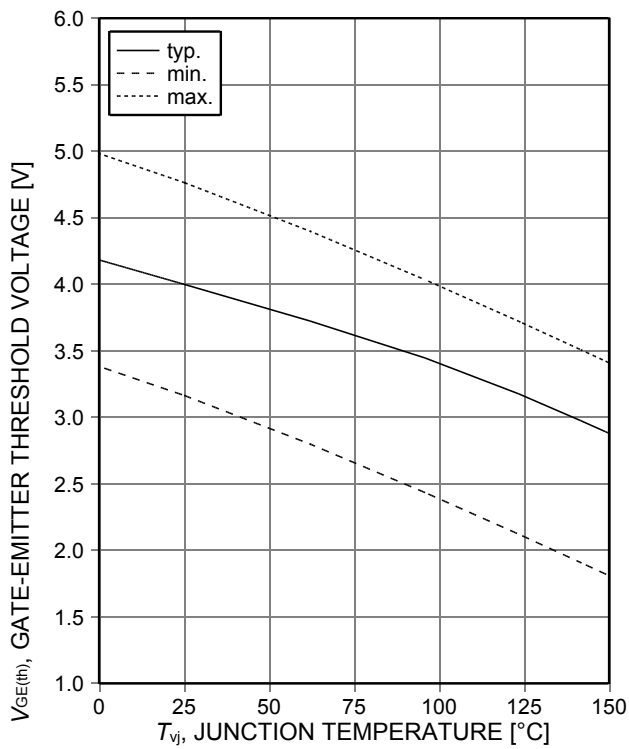


Figure 11. Gate-emitter threshold voltage as a function of junction temperature

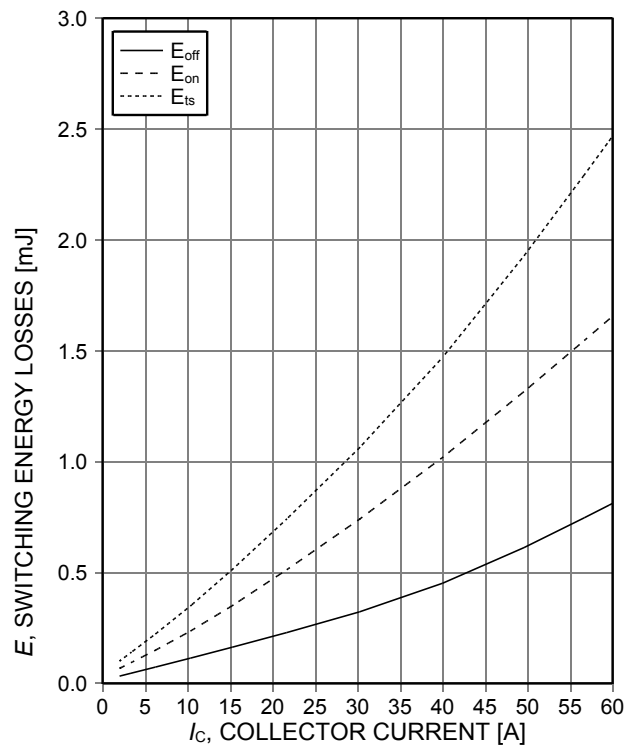


Figure 12. Typical switching energy losses as a function of collector current

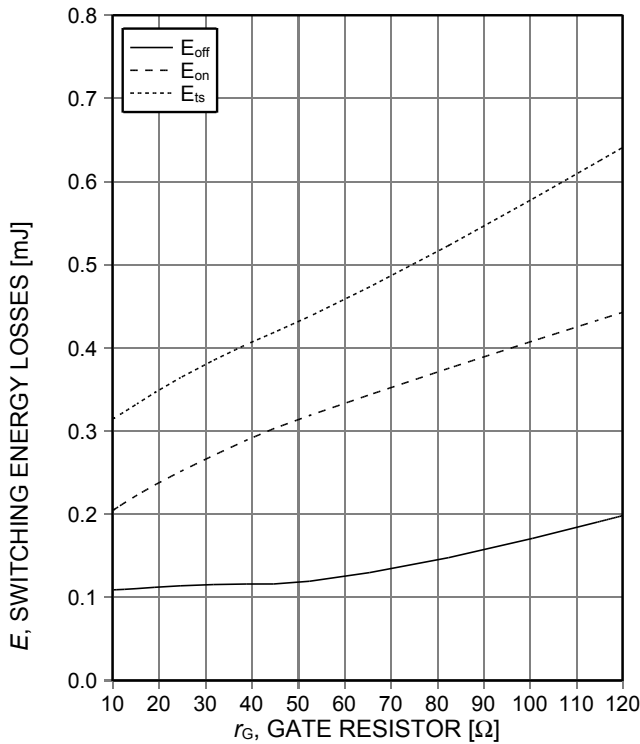


Figure 13. Typical switching energy losses as a function of gate resistor

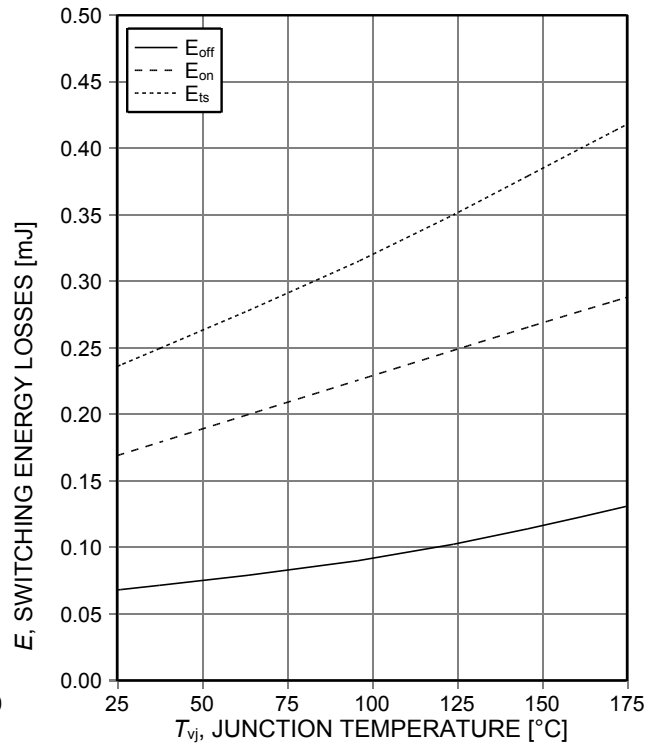


Figure 14. Typical switching energy losses as a function of junction temperature

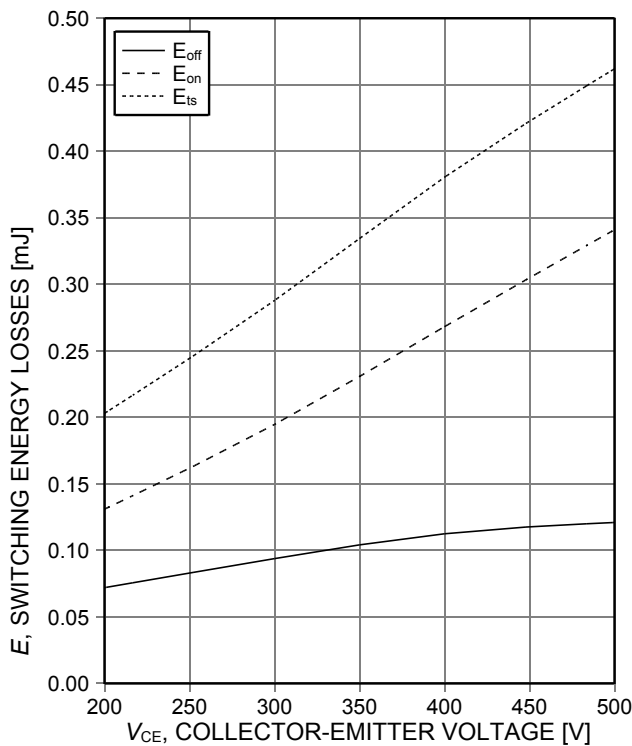


Figure 15. Typical switching energy losses as a function of collector emitter voltage

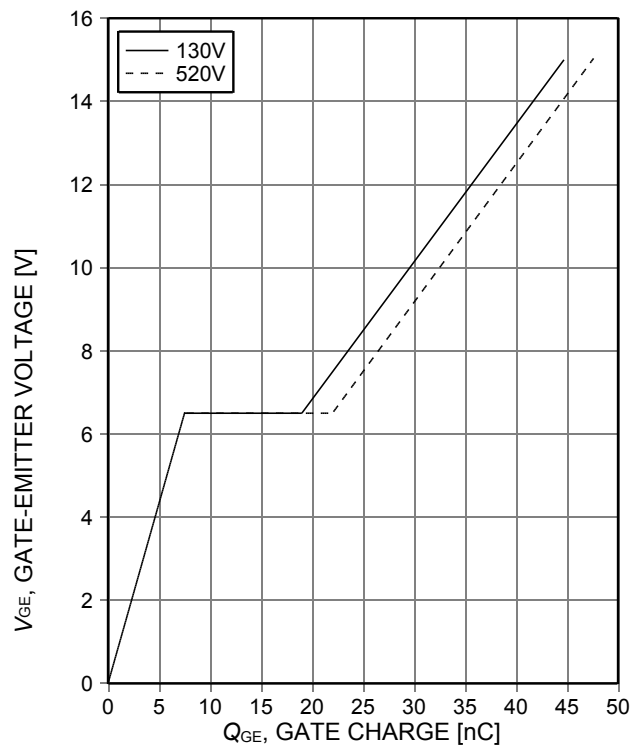


Figure 16. Typical gate charge

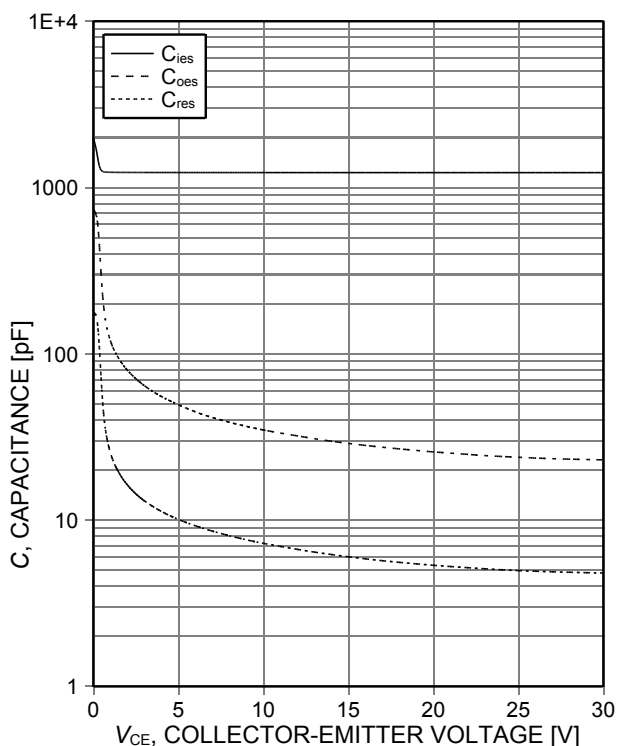


Figure 17. Typical capacitance as a function of collector-emitter voltage

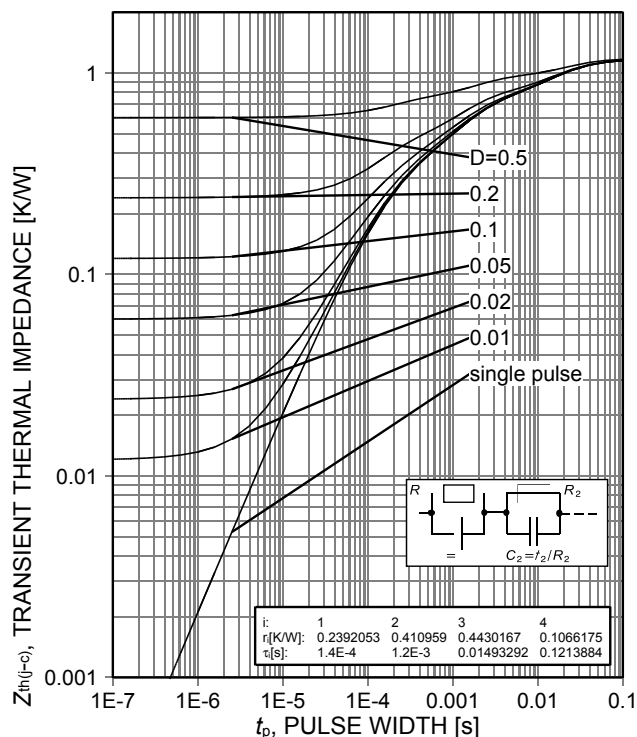


Figure 18. IGBT transient thermal impedance

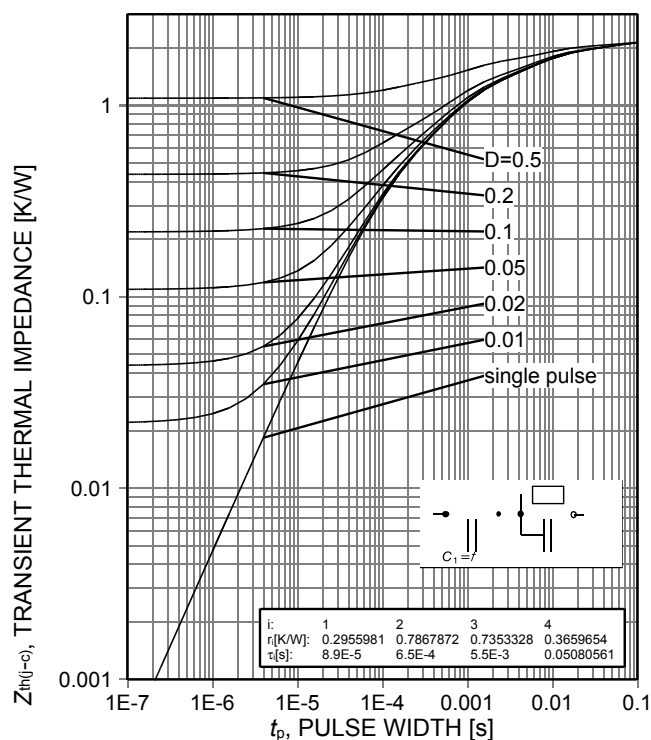


Figure 19. Diode transient thermal impedance as a function of pulse width

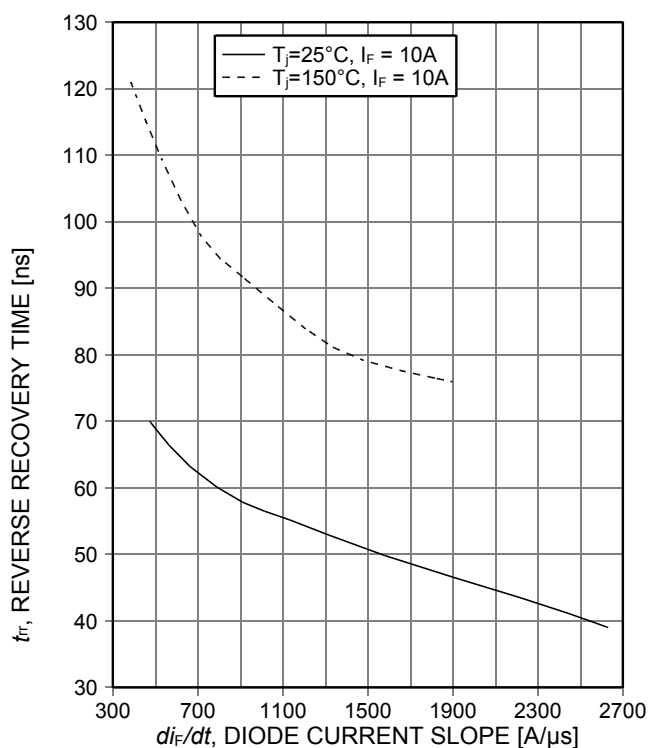
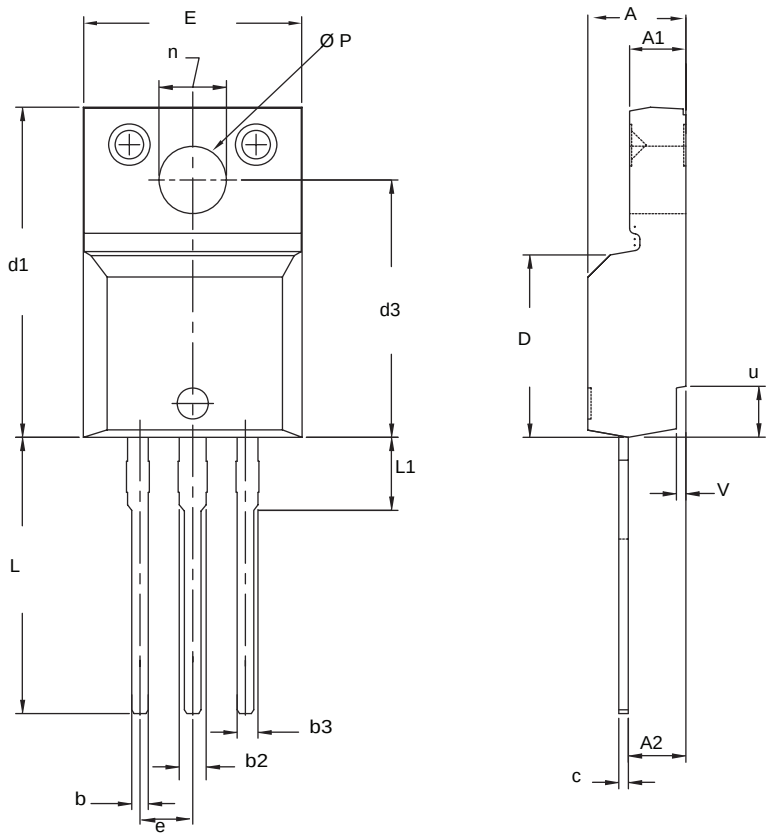


Figure 20. Typical reverse recovery time as a function of diode current slope

**TO-220 FULLPAK (HIGH VOLTAGE)**



| DIM. | MILLIMETERS |        | INCHES    |       |
|------|-------------|--------|-----------|-------|
|      | MIN.        | MAX.   | MIN.      | MAX.  |
| A    | 4.570       | 4.830  | 0.180     | 0.190 |
| A1   | 2.570       | 2.830  | 0.101     | 0.111 |
| A2   | 2.510       | 2.850  | 0.099     | 0.112 |
| b    | 0.622       | 0.890  | 0.024     | 0.035 |
| b2   | 1.229       | 1.400  | 0.048     | 0.055 |
| b3   | 1.229       | 1.400  | 0.048     | 0.055 |
| c    | 0.440       | 0.629  | 0.017     | 0.025 |
| D    | 8.650       | 9.800  | 0.341     | 0.386 |
| d1   | 15.88       | 16.120 | 0.622     | 0.635 |
| d3   | 12.300      | 12.920 | 0.484     | 0.509 |
| E    | 10.360      | 10.630 | 0.408     | 0.419 |
| e    | 2.54 BSC    |        | 0.100 BSC |       |
| L    | 13.200      | 13.730 | 0.520     | 0.541 |
| L1   | 3.100       | 3.500  | 0.122     | 0.138 |
| n    | 6.050       | 6.150  | 0.238     | 0.242 |
| Ø P  | 3.050       | 3.450  | 0.120     | 0.136 |
| u    | 2.400       | 2.500  | 0.094     | 0.098 |
| v    | 0.400       | 0.500  | 0.016     | 0.020 |

ECN: X09-0126-Rev. B, DWG: 5972

**Notes**

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.3
3. All critical dimensions should C meet  $C_{pk} > 1.33$ .
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.



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