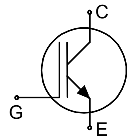
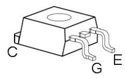
## Fast IGBT in NPT-technology




- 75% lower $E_{off}$ compared to previous generation combined with low conduction losses
- Short circuit withstand time – 10 µs
- Designed for:
  - Motor controls
  - Inverter
- NPT-Technology for 600V applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behaviour
  - parallel switching capability




PG-TO-263-3-2 (D²-PAK)
(TO-263AB)

- Qualified according to JEDEC[2] for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/

| Type | $V_{CE}$ | $I_C$ | $V_{CE(sat)150°C}$ | $T_j$ | Marking | Package |
|---|---|---|---|---|---|---|
| SGB02N60 | 600V | 2A | 2.2V | 150°C | G02N60 | PG-TO-263-3-2 |

**Maximum Ratings**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 600 | V |
| DC collector current<br>$T_C$ = 25°C<br>$T_C$ = 100°C | $I_C$ | <br>6.0<br>2.9 | A |
| Pulsed collector current, $t_p$ limited by $T_{jmax}$ | $I_{Cpuls}$ | 12 | |
| Turn off safe operating area<br>$V_{CE} \leq 600V$, $T_j \leq 150°C$ | - | 12 | |
| Gate-emitter voltage | $V_{GE}$ | ±20 | V |
| Avalanche energy, single pulse<br>$I_C$ = 2 A, $V_{CC}$ = 50 V, $R_{GE}$ = 25 Ω,<br>start at $T_j$ = 25°C | $E_{AS}$ | 13 | mJ |
| Short circuit withstand time[1)]<br>$V_{GE}$ = 15V, $V_{CC} \leq 600V$, $T_j \leq 150°C$ | $t_{SC}$ | 10 | µs |
| Power dissipation<br>$T_C$ = 25°C | $P_{tot}$ | 30 | W |
| Operating junction and storage temperature | $T_j$ , $T_{stg}$ | -55...+150 | °C |
| Soldering temperature (reflow soldering, MSL1) | | 245 | |

[2] J-STD-020 and JESD-022
[1)] Allowed number of short circuits: <1000; time between short circuits: >1s.

**Thermal Resistance**

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---|---|---|---|
| **Characteristic** | | | | |
| IGBT thermal resistance, junction – case | $R_{thJC}$ | | 4.2 | K/W |
| Thermal resistance, junction – ambient[1)] | $R_{thJA}$ | | 40 | |

**Electrical Characteristic,** at $T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | Typ. | max. | |
| **Static Characteristic** | | | | | | |
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$=0V, $I_C$=500µA | 600 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE}$ = 15V, $I_C$=2A<br>$T_j$=25°C<br>$T_j$=150°C | <br>1.7<br>- | <br>1.9<br>2.2 | <br>2.4<br>2.7 | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$=150µA, $V_{CE}$=$V_{GE}$ | 3 | 4 | 5 | |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$=600V, $V_{GE}$=0V<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>-<br>- | <br>20<br>250 | µA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V | - | - | 100 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$=20V, $I_C$=2A | - | 1.6 | - | S |
| **Dynamic Characteristic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{CE}$=25V, | - | 142 | 170 | pF |
| Output capacitance | $C_{oss}$ | $V_{GE}$=0V, | - | 18 | 22 | |
| Reverse transfer capacitance | $C_{rss}$ | $f$=1MHz | - | 10 | 12 | |
| Gate charge | $Q_{Gate}$ | $V_{CC}$=480V, $I_C$=2A<br>$V_{GE}$=15V | - | 14 | 18 | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$ | | - | 7 | - | nH |
| Short circuit collector current[2)] | $I_{C(SC)}$ | $V_{GE}$=15V, $t_{SC}$≤10µs<br>$V_{CC}$ ≤ 600V,<br>$T_j$ ≤ 150°C | - | 20 | - | A |

1) Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm$^2$ (one layer, 70µm thick) copper area for collector connection. PCB is vertical without blown air.
2) Allowed number of short circuits: <1000; time between short circuits: >1s.

**Switching Characteristic, Inductive Load,** at $T_j$=25 °C

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=25°C, $V_{CC}$=400V, $I_C$=2A, $V_{GE}$=0/15V, $R_G$=118Ω, $L_\sigma$[1) ]=180nH, $C_\sigma$[1) ]=180pF Energy losses include "tail" and diode reverse recovery. | - | 20 | 24 | ns |
| Rise time | $t_r$ | | - | 13 | 16 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 259 | 311 | |
| Fall time | $t_f$ | | - | 52 | 62 | |
| Turn-on energy | $E_{on}$ | | - | 0.036 | 0.041 | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.028 | 0.036 | |
| Total switching energy | $E_{ts}$ | | - | 0.064 | 0.078 | |

**Switching Characteristic, Inductive Load,** at $T_j$=150 °C

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=150°C, $V_{CC}$=400V, $I_C$=2A, $V_{GE}$=0/15V, $R_G$=118Ω, $L_\sigma$[1) ]=180nH, $C_\sigma$[1) ]=180pF Energy losses include "tail" and diode reverse recovery. | - | 20 | 24 | ns |
| Rise time | $t_r$ | | - | 14 | 17 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 287 | 344 | |
| Fall time | $t_f$ | | - | 67 | 80 | |
| Turn-on energy | $E_{on}$ | | - | 0.054 | 0.062 | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.043 | 0.056 | |
| Total switching energy | $E_{ts}$ | | - | 0.097 | 0.118 | |

[1)] Leakage inductance $L_\sigma$ and Stray capacity $C_\sigma$ due to dynamic test circuit in Figure E.

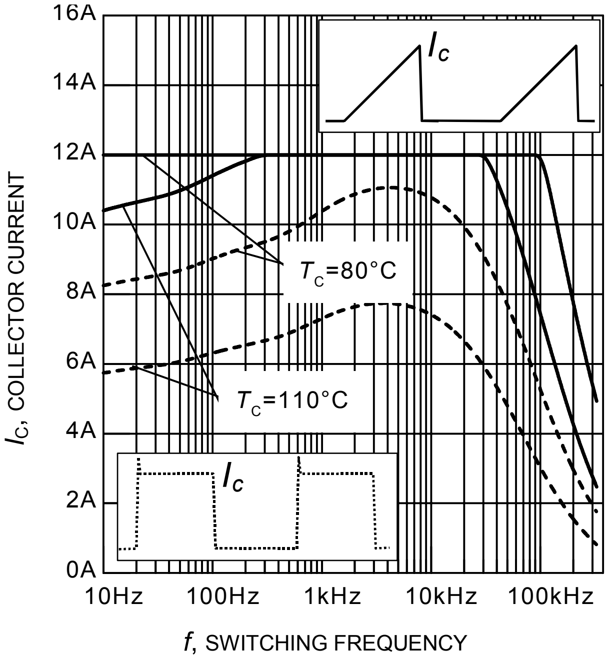



**Figure 1. Collector current as a function of switching frequency**
($T_j \leq 150°C$, $D$ = 0.5, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $R_G$ = 118Ω)

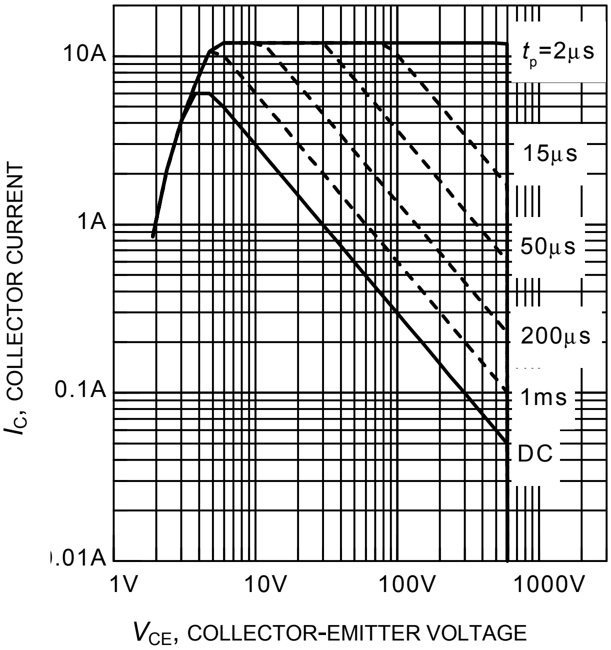



**Figure 2. Safe operating area**
($D$ = 0, $T_C$ = 25°C, $T_j \leq 150°C$)

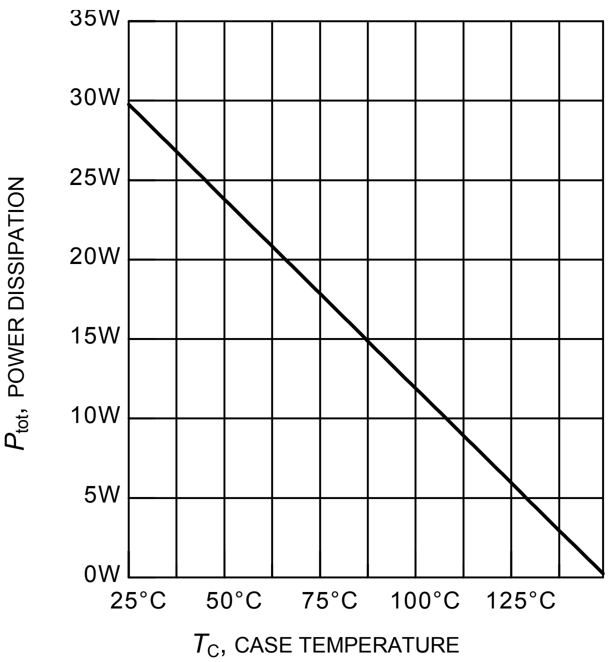



**Figure 3. Power dissipation (IGBT) as a function of case temperature**
($T_j \leq 150°C$)

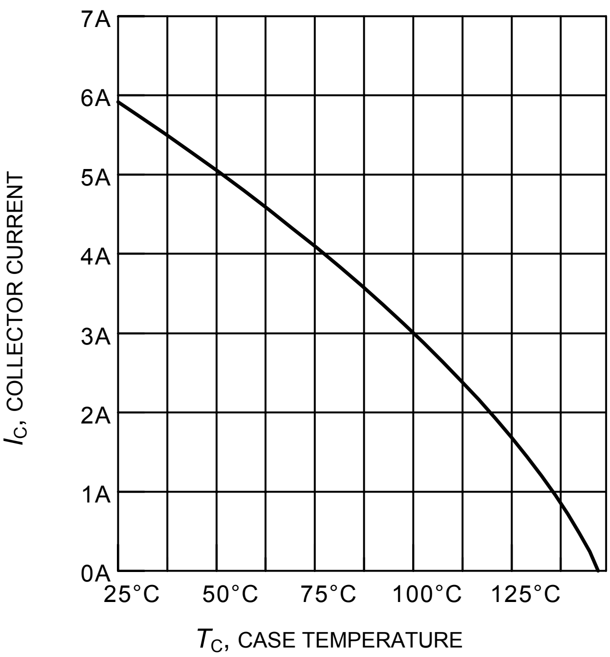



**Figure 4. Collector current as a function of case temperature**
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

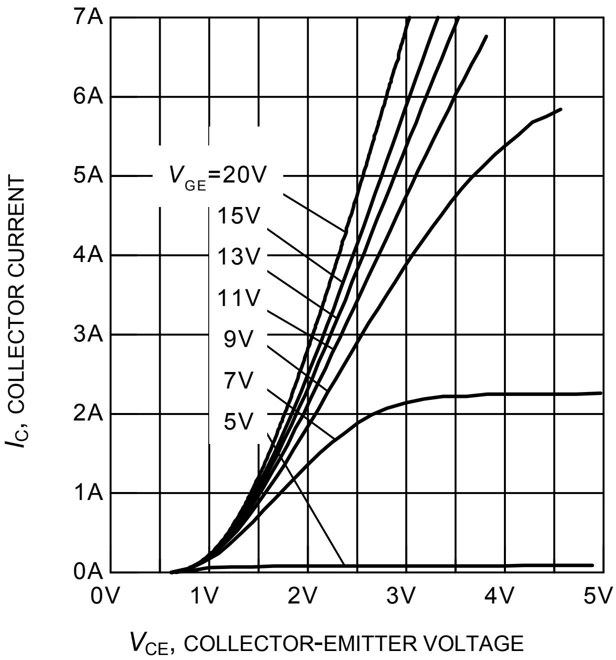



**Figure 5. Typical output characteristics**
($T_j$ = 25°C)

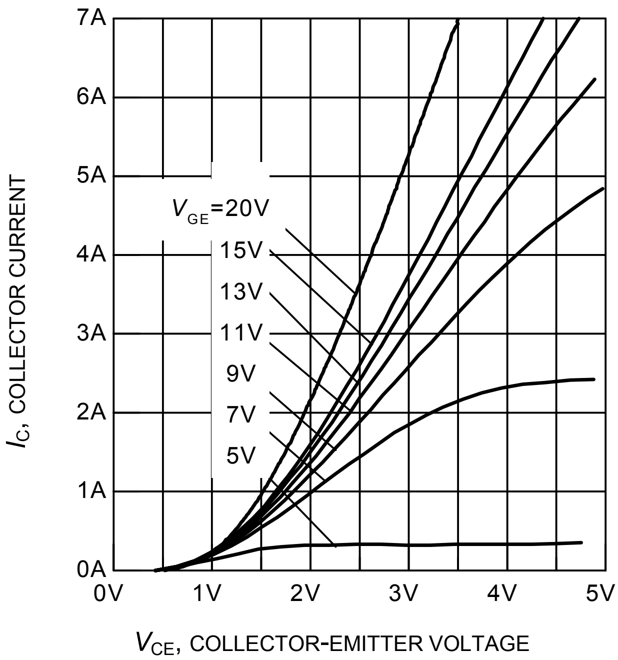



**Figure 6. Typical output characteristics**
($T_j$ = 150°C)

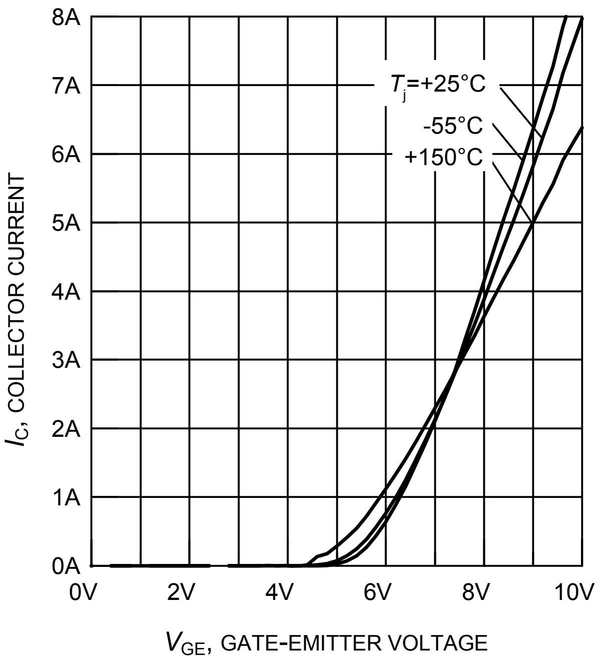



**Figure 7. Typical transfer characteristics**
($V_{CE}$ = 10V)

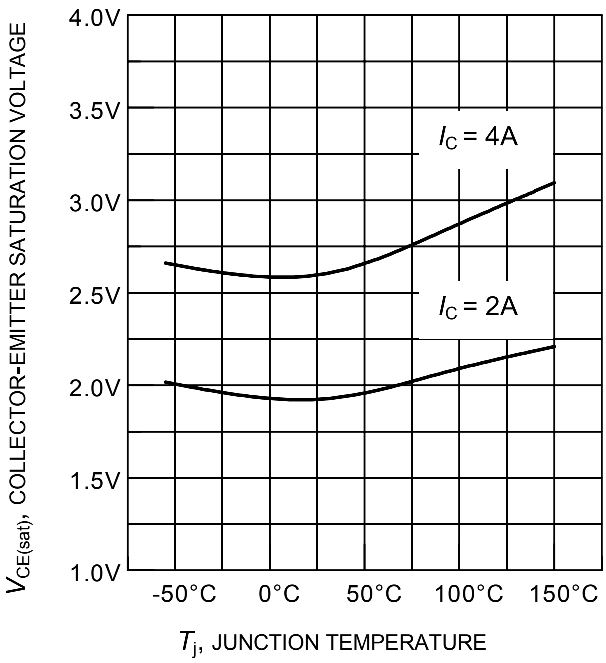



**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}$ = 15V)

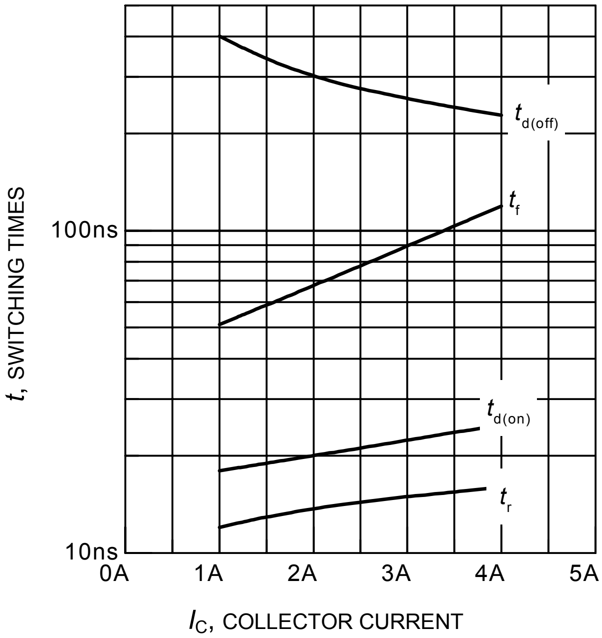



**Figure 9. Typical switching times as a function of collector current**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $R_G$ = 118Ω, Dynamic test circuit in Figure E)

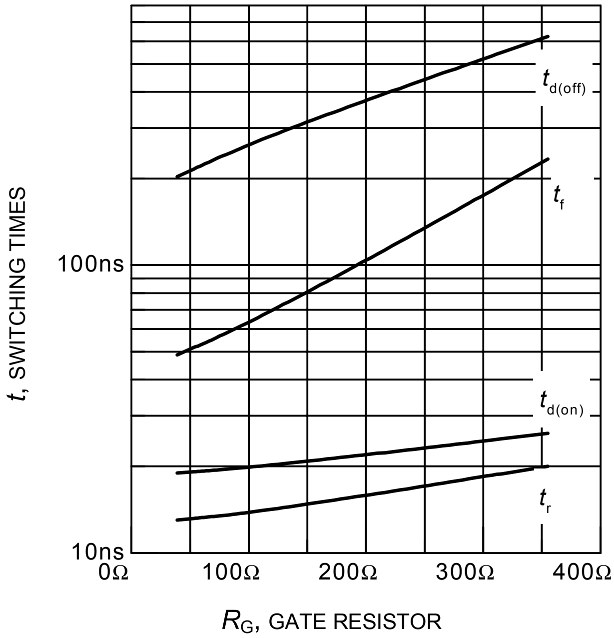



**Figure 10. Typical switching times as a function of gate resistor**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $I_C$ = 2A, Dynamic test circuit in Figure E)

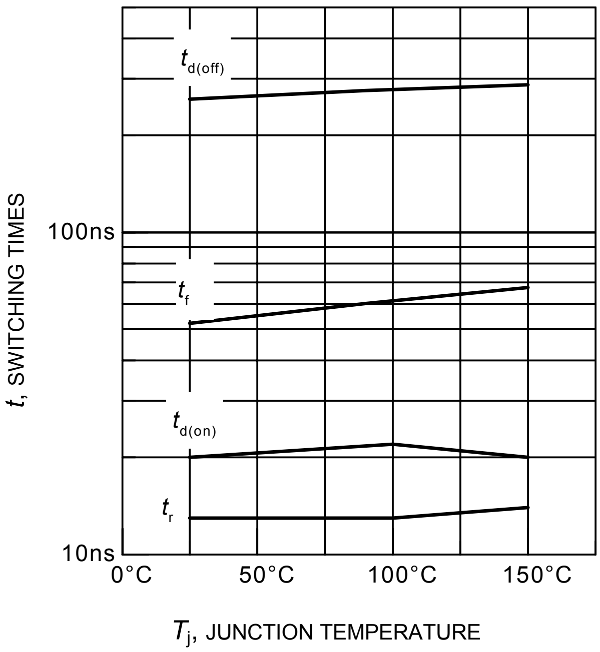



**Figure 11. Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $I_C$ = 2A, $R_G$ = 118Ω, Dynamic test circuit in Figure E)

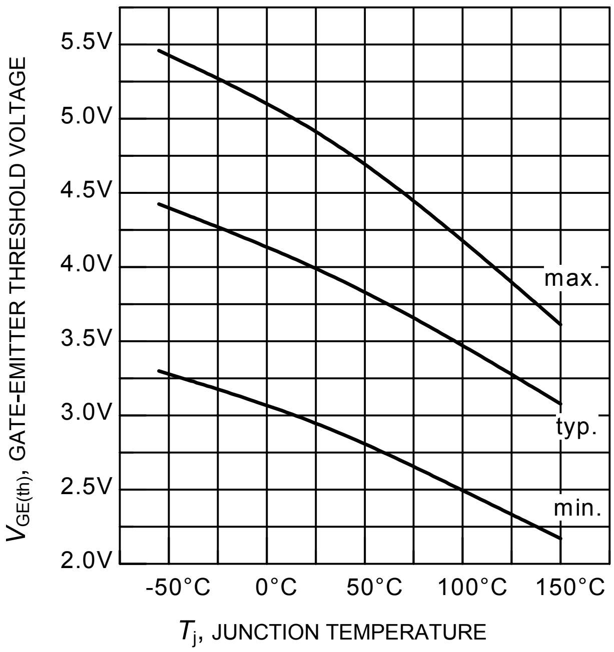



**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**
($I_C$ = 0.15mA)

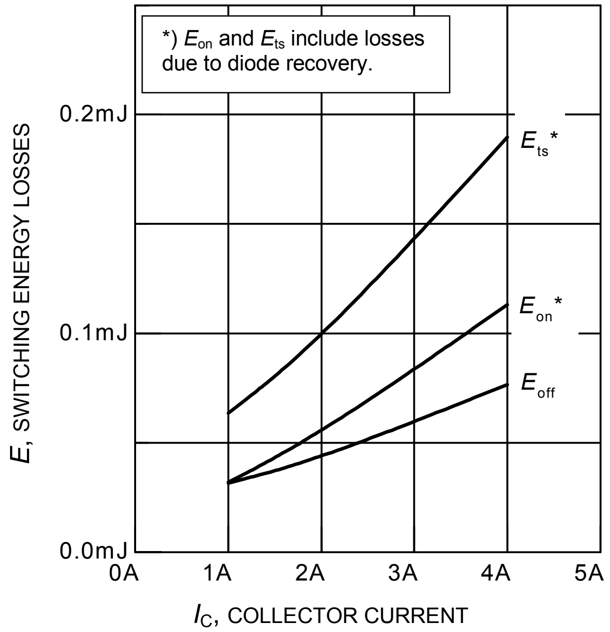



**Figure 13. Typical switching energy losses as a function of collector current**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $R_G$ = 118Ω, Dynamic test circuit in Figure E)

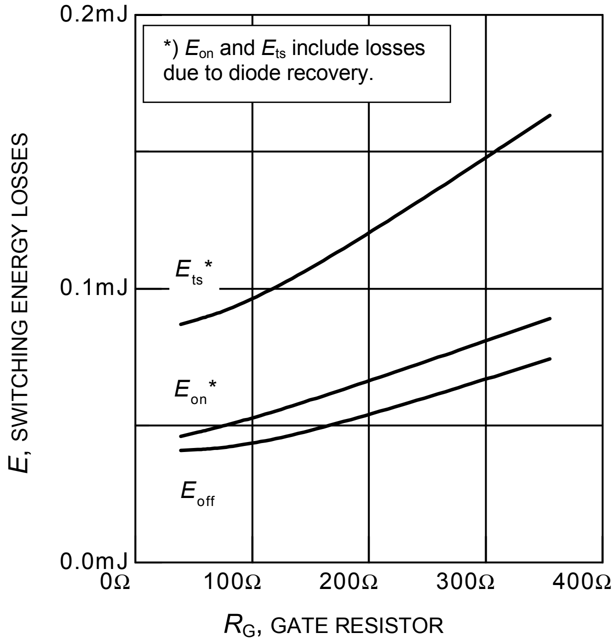



**Figure 14. Typical switching energy losses as a function of gate resistor**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $I_C$ = 2A, Dynamic test circuit in Figure E)

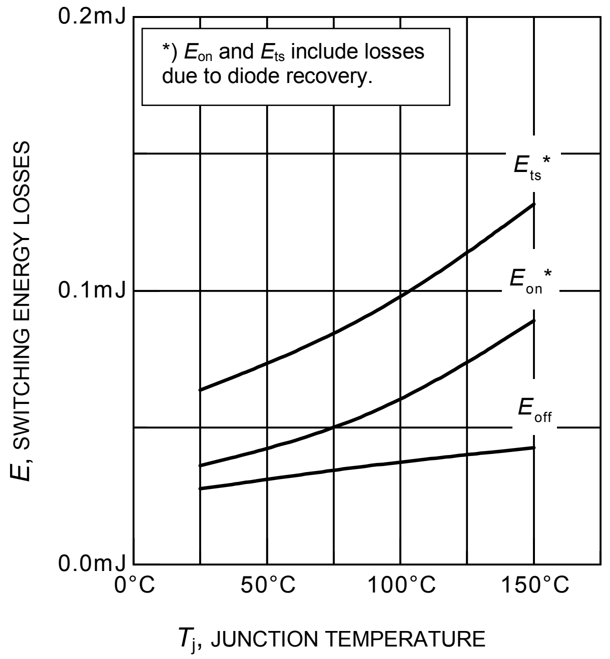



**Figure 15. Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}$ = 400V, $V_{GE}$ = 0/+15V, $I_C$ = 2A, $R_G$ = 118Ω, Dynamic test circuit in Figure E)

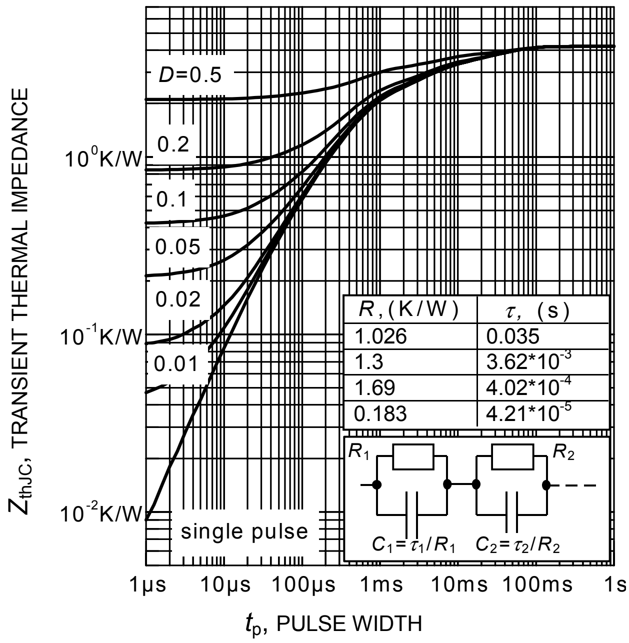



**Figure 16. IGBT transient thermal impedance as a function of pulse width**
($D = t_p / T$)

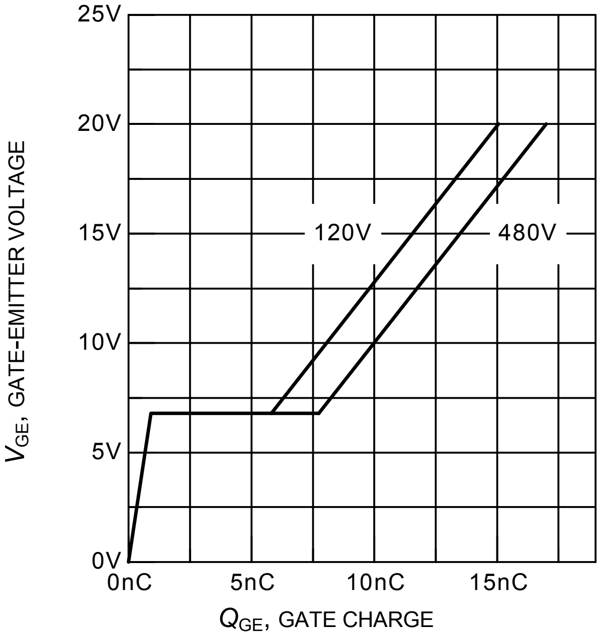



**Figure 17. Typical gate charge**
($I_C$ = 2A)

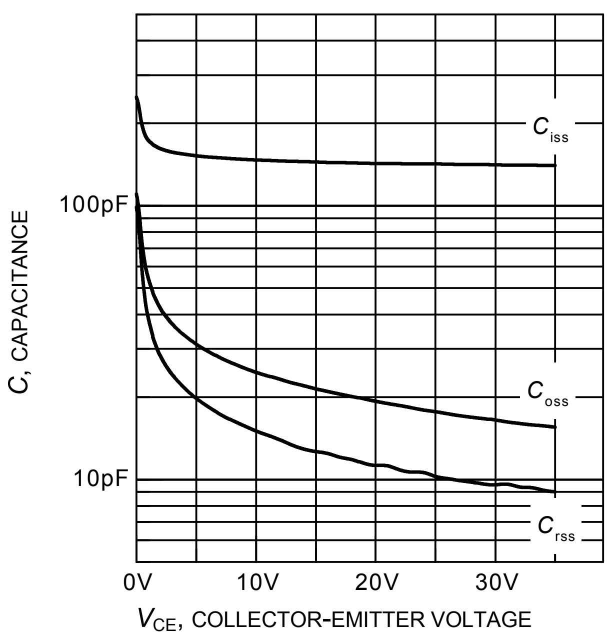



**Figure 18. Typical capacitance as a function of collector-emitter voltage**
($V_{GE}$ = 0V, $f$ = 1MHz)

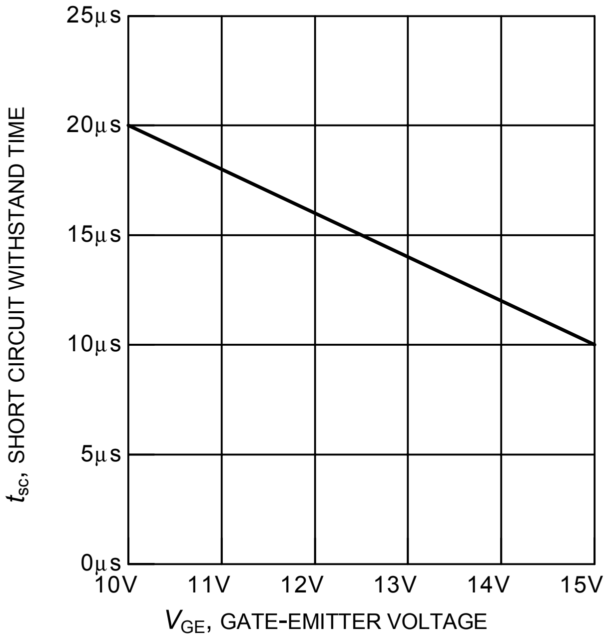



**Figure 19. Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE}$ = 600V, start at $T_j$ = 25°C)

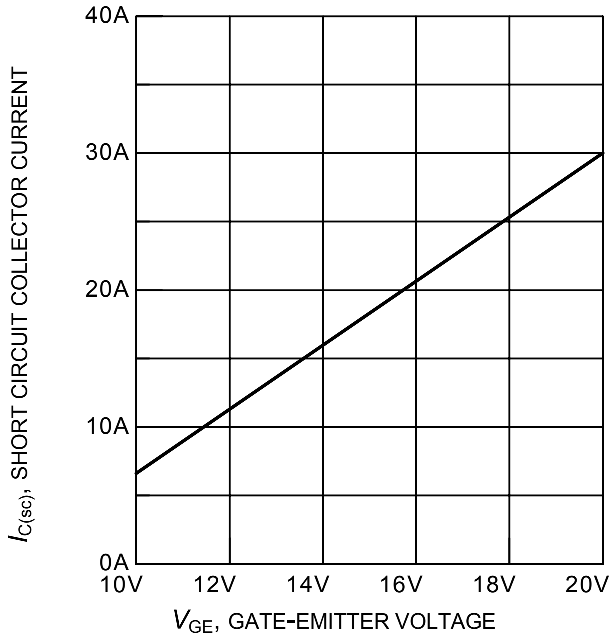



**Figure 20. Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE} \leq$ 600V, $T_j$ = 150°C)

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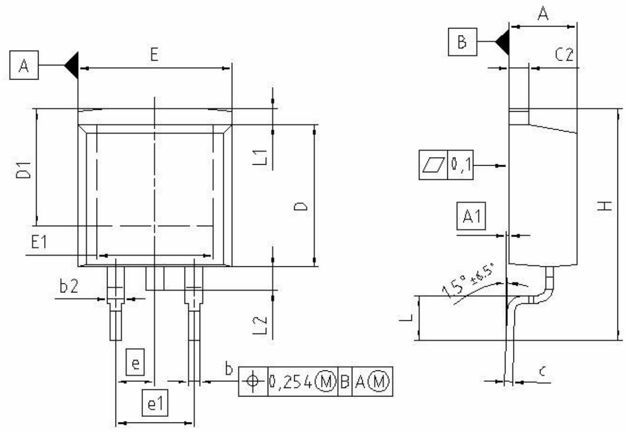
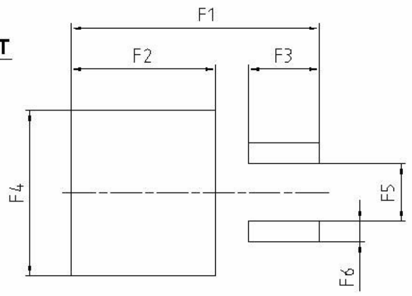


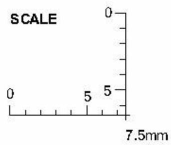

**FOOTPRINT**



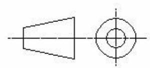

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 0.000 | 0.254 | 0.000 | 0.010 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b2 | 0.950 | 1.321 | 0.037 | 0.052 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c2 | 0.170 | 1.400 | 0.046 | 0.055 |
| D | 8.509 | 9.450 | 0.335 | 0.372 |
| D1 | 7.100 | - | 0.280 | - |
| E | 9.800 | 10.312 | 0.386 | 0.406 |
| E1 | 6.500 | | 0.256 | |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.605 | 15.875 | 0.575 | 0.625 |
| L | 2.200 | 3.000 | 0.087 | 0.118 |
| L1 | - | 1.600 | - | 0.063 |
| L2 | 1.000 | 1.778 | 0.039 | 0.070 |
| F1 | 16.050 | 16.250 | 0.632 | 0.640 |
| F2 | 9.300 | 9.500 | 0.366 | 0.374 |
| F3 | 4.500 | 4.700 | 0.177 | 0.185 |
| F4 | 10.700 | 10.900 | 0.421 | 0.429 |
| F5 | 3.630 | 3.830 | 0.143 | 0.151 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |

REFERENCE
JEDEC TO263

SCALE




EUROPEAN PROJECTION



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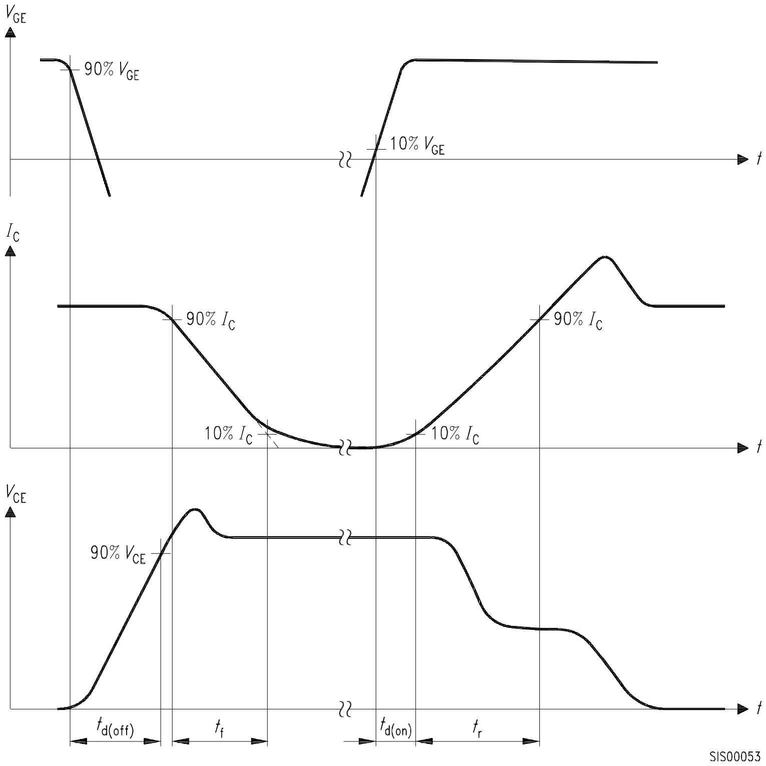


**Figure A. Definition of switching times**

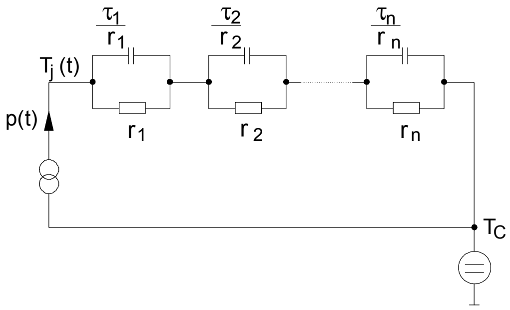


**Figure D. Thermal equivalent circuit**

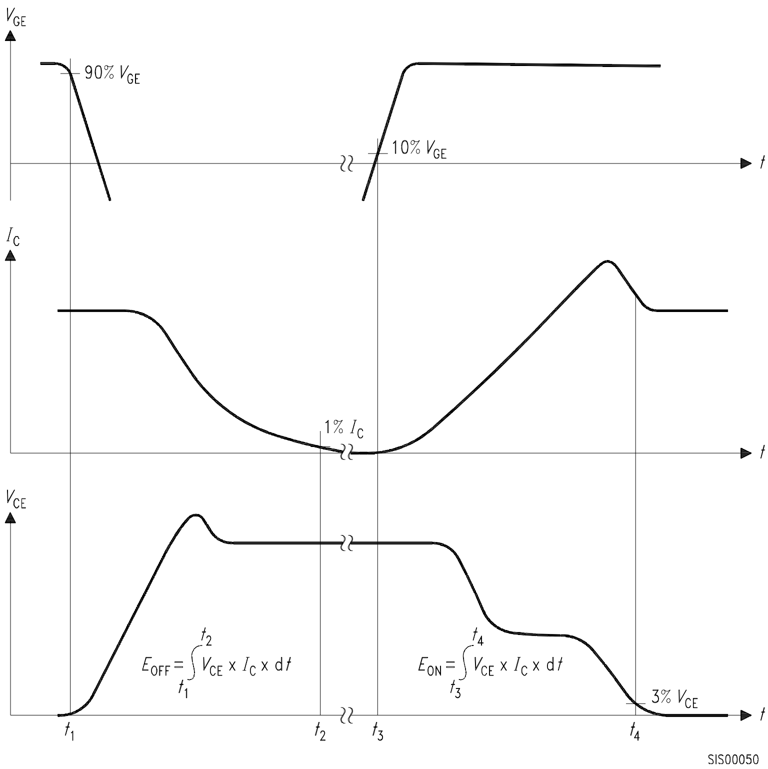


**Figure B. Definition of switching losses**

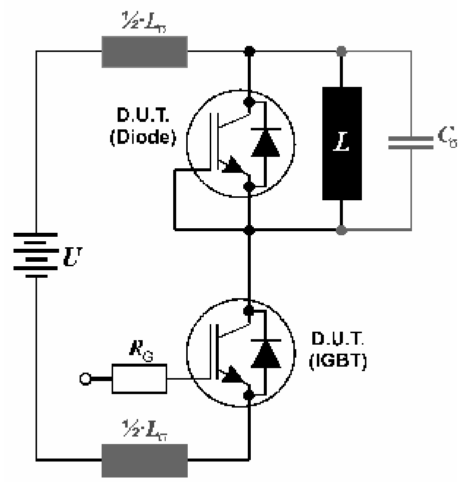


**Figure E. Dynamic test circuit**

Leakage inductance $L_{\sigma}$ =180nH

and Stray capacity $C_{\sigma}$ =180pF.

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