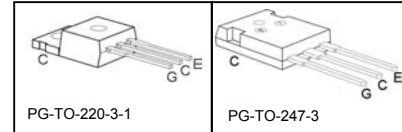
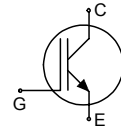


## High Speed IGBT in NPT-technology

- 30% lower  $E_{off}$  compared to previous generation
- Short circuit withstand time – 10  $\mu$ s
- Designed for operation above 30 kHz
- NPT-Technology for 600V applications offers:
  - parallel switching capability
  - moderate  $E_{off}$  increase with temperature
  - very tight parameter distribution
- High ruggedness, temperature stable behaviour
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>1</sup> for target applications
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



| Type       | $V_{CE}$ | $I_C$ | $E_{off}$   | $T_j$ | Marking  | Package       |
|------------|----------|-------|-------------|-------|----------|---------------|
| SGP20N60HS | 600V     | 20    | 240 $\mu$ J | 150°C | G20N60HS | PG-TO-220-3-1 |
| SGW20N60HS | 600V     | 20    | 240 $\mu$ J | 150°C | G20N60HS | PG-TO-247-3   |

### Maximum Ratings

| Parameter                                                                                                                      | Symbol               | Value                | Unit             |
|--------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|------------------|
| Collector-emitter voltage                                                                                                      | $V_{CE}$             | 600                  | V                |
| DC collector current<br>$T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                                                  | $I_C$                | 36<br>20             | A                |
| Pulsed collector current, $t_p$ limited by $T_{jmax}$                                                                          | $I_{Cpuls}$          | 80                   |                  |
| Turn off safe operating area<br>$V_{CE} \leq 600\text{V}$ , $T_j \leq 150^\circ\text{C}$                                       | -                    | 80                   |                  |
| Avalanche energy single pulse<br>$I_C = 20\text{A}$ , $V_{CC}=50\text{V}$ , $R_{GE}=25\Omega$<br>start $T_j=25^\circ\text{C}$  | $E_{AS}$             | 115                  | mJ               |
| Gate-emitter voltage static<br>transient ( $t_p < 1\mu\text{s}$ , $D < 0.05$ )                                                 | $V_{GE}$             | $\pm 20$<br>$\pm 30$ | V                |
| Short circuit withstand time <sup>2)</sup><br>$V_{GE} = 15\text{V}$ , $V_{CC} \leq 600\text{V}$ , $T_j \leq 150^\circ\text{C}$ | $t_{SC}$             | 10                   | $\mu\text{s}$    |
| Power dissipation<br>$T_C = 25^\circ\text{C}$                                                                                  | $P_{tot}$            | 178                  | W                |
| Operating junction and storage temperature                                                                                     | $T_j$ ,<br>$T_{stg}$ | -55...+150           | $^\circ\text{C}$ |
| Time limited operating junction temperature for $t < 150\text{h}$                                                              | $T_{j(tl)}$          | 175                  |                  |
| Soldering temperature, 1.6mm (0.063 in.) from case for 10s                                                                     | -                    | 260                  |                  |

<sup>1</sup> J-STD-020 and JEDEC-022

<sup>2)</sup> Allowed number of short circuits: <1000; time between short circuits: >1s.

## Thermal Resistance

| Parameter                                | Symbol     | Conditions     | Max. Value | Unit |
|------------------------------------------|------------|----------------|------------|------|
| <b>Characteristic</b>                    |            |                |            |      |
| IGBT thermal resistance, junction – case | $R_{thJC}$ |                | 0.7        | K/W  |
| Thermal resistance, junction – ambient   | $R_{thJA}$ | PG-TO-220-3-1  | 62         |      |
|                                          |            | PG-TO-247-3-21 | 40         |      |

## Electrical Characteristic, at $T_j = 25^\circ\text{C}$ , unless otherwise specified

| Parameter                            | Symbol        | Conditions                                                          | Value  |            |              | Unit    |
|--------------------------------------|---------------|---------------------------------------------------------------------|--------|------------|--------------|---------|
|                                      |               |                                                                     | min.   | Typ.       | max.         |         |
| Static Characteristic                |               |                                                                     |        |            |              |         |
| Collector-emitter breakdown voltage  | $V_{(BR)CES}$ | $V_{GE}=0V, I_C=500\mu A$                                           | 600    | -          | -            | V       |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE} = 15V, I_C=20A$<br>$T_j=25^{\circ}C$<br>$T_j=150^{\circ}C$  |        | 2.8<br>3.5 | 3.15<br>4.00 |         |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $I_C=500\mu A, V_{CE}=V_{GE}$                                       | 3      | 4          | 5            |         |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE}=600V, V_{GE}=0V$<br>$T_j=25^{\circ}C$<br>$T_j=150^{\circ}C$ | -<br>- | -<br>-     | 40<br>2500   | $\mu A$ |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{CE}=0V, V_{GE}=20V$                                             | -      | -          | 100          | nA      |
| Transconductance                     | $g_{fs}$      | $V_{CE}=20V, I_C=20A$                                               | -      | 14         |              | S       |

## Dynamic Characteristic

|                                                                   |             |                                                                                       |   |      |  |    |
|-------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------|---|------|--|----|
| Input capacitance                                                 | $C_{iss}$   | $V_{CE}=25V,$<br>$V_{GE}=0V,$<br>$f=1\text{MHz}$                                      | - | 1100 |  | pF |
| Output capacitance                                                | $C_{oss}$   |                                                                                       | - | 105  |  |    |
| Reverse transfer capacitance                                      | $C_{rss}$   |                                                                                       | - | 64   |  |    |
| Gate charge                                                       | $Q_{Gate}$  | $V_{CC}=480V, I_C=20A$<br>$V_{GE}=15V$                                                | - | 100  |  | nC |
| Internal emitter inductance<br>measured 5mm (0.197 in.) from case | $L_E$       | PG-TO-220-3-1                                                                         | - | 7    |  | nH |
|                                                                   |             | PG-TO-247-3-21                                                                        |   | 13   |  |    |
| Short circuit collector current <sup>1)</sup>                     | $I_{C(SC)}$ | $V_{GE}=15V, t_{SC}\leq 10\mu s$<br>$V_{CC}\leq 600V,$<br>$T_j\leq 150^\circ\text{C}$ | - | 170  |  | A  |

<sup>1)</sup> Allowed number of short circuits: <1000; time between short circuits: >1s.

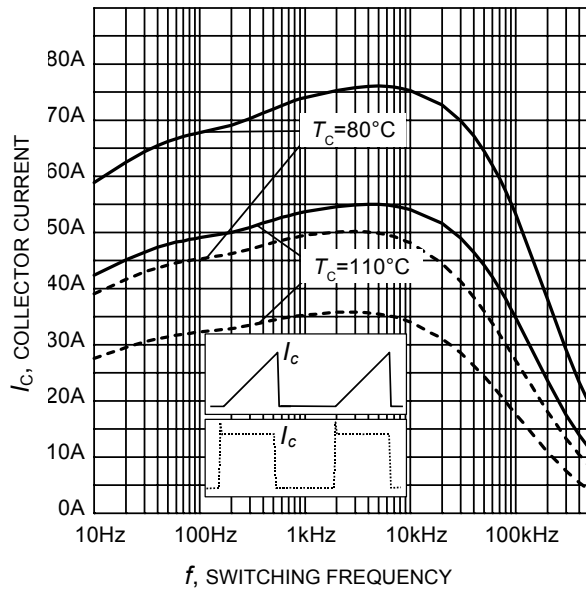
## Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

| Parameter              | Symbol       | Conditions                                                                                                                                                                                                                                                 | Value |      |      | Unit |
|------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|
|                        |              |                                                                                                                                                                                                                                                            | min.  | typ. | max. |      |
| IGBT Characteristic    |              |                                                                                                                                                                                                                                                            |       |      |      |      |
| Turn-on delay time     | $t_{d(on)}$  | $T_j=25^{\circ}\text{C}$ ,<br>$V_{CC}=400\text{V}$ , $I_C=20\text{A}$ ,<br>$V_{GE}=0/15\text{V}$ ,<br>$R_G=16\Omega$<br>$L_{\sigma}^{1)}=60\text{nH}$ ,<br>$C_{\sigma}^{1)}=40\text{pF}$<br>Energy losses include<br>“tail” and diode<br>reverse recovery. | -     | 18   |      | ns   |
| Rise time              | $t_r$        |                                                                                                                                                                                                                                                            | -     | 15   |      |      |
| Turn-off delay time    | $t_{d(off)}$ |                                                                                                                                                                                                                                                            | -     | 207  |      |      |
| Fall time              | $t_f$        |                                                                                                                                                                                                                                                            | -     | 13   |      |      |
| Turn-on energy         | $E_{on}$     |                                                                                                                                                                                                                                                            | -     | 0.39 |      | mJ   |
| Turn-off energy        | $E_{off}$    |                                                                                                                                                                                                                                                            | -     | 0.30 |      |      |
| Total switching energy | $E_{ts}$     |                                                                                                                                                                                                                                                            | -     | 0.69 |      |      |

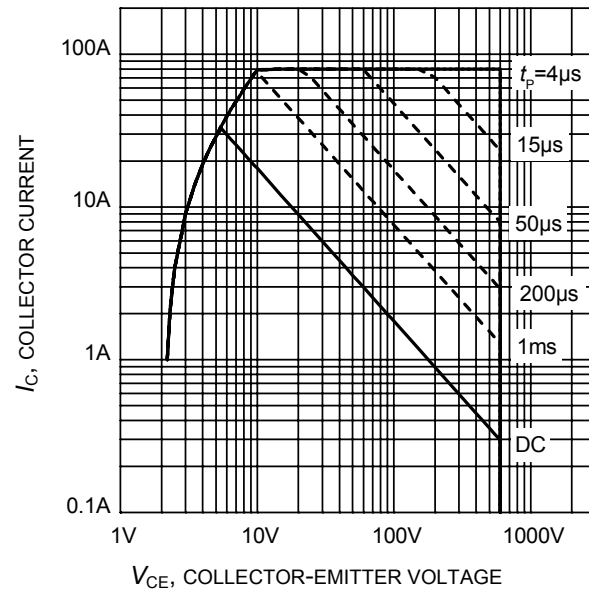
## Switching Characteristic, Inductive Load, at $T_j=150^\circ\text{C}$

| Parameter              | Symbol       | Conditions                                                                                                                                                                                                                                           | Value |      |      | Unit |
|------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|
|                        |              |                                                                                                                                                                                                                                                      | min.  | typ. | max. |      |
| IGBT Characteristic    |              |                                                                                                                                                                                                                                                      |       |      |      |      |
| Turn-on delay time     | $t_{d(on)}$  | $T_j=150^{\circ}\text{C}$<br>$V_{CC}=400\text{V}, I_C=20\text{A},$<br>$V_{GE}=0/15\text{V},$<br>$R_G=2.2\Omega$<br>$L_{\sigma}^{1)}=60\text{nH},$<br>$C_{\sigma}^{1)}=40\text{pF}$<br>Energy losses include<br>“tail” and diode<br>reverse recovery. | -     | 15   |      | ns   |
| Rise time              | $t_r$        |                                                                                                                                                                                                                                                      | -     | 8.5  |      |      |
| Turn-off delay time    | $t_{d(off)}$ |                                                                                                                                                                                                                                                      | -     | 65   |      |      |
| Fall time              | $t_f$        |                                                                                                                                                                                                                                                      | -     | 35   |      |      |
| Turn-on energy         | $E_{on}$     | Energy losses include<br>“tail” and diode<br>reverse recovery.                                                                                                                                                                                       | -     | 0.46 |      | mJ   |
| Turn-off energy        | $E_{off}$    |                                                                                                                                                                                                                                                      | -     | 0.24 |      |      |
| Total switching energy | $E_{ts}$     |                                                                                                                                                                                                                                                      | -     | 0.7  |      |      |
| Turn-on delay time     | $t_{d(on)}$  | $T_j=150^{\circ}\text{C}$<br>$V_{CC}=400\text{V}, I_C=20\text{A},$<br>$V_{GE}=0/15\text{V},$<br>$R_G=16\Omega$<br>$L_{\sigma}^{1)}=60\text{nH},$<br>$C_{\sigma}^{1)}=40\text{pF}$<br>Energy losses include<br>“tail” and diode<br>reverse recovery.  | -     | 17   |      | ns   |
| Rise time              | $t_r$        |                                                                                                                                                                                                                                                      | -     | 13   |      |      |
| Turn-off delay time    | $t_{d(off)}$ |                                                                                                                                                                                                                                                      | -     | 222  |      |      |
| Fall time              | $t_f$        |                                                                                                                                                                                                                                                      | -     | 13   |      |      |
| Turn-on energy         | $E_{on}$     |                                                                                                                                                                                                                                                      | -     | 0.6  |      | mJ   |
| Turn-off energy        | $E_{off}$    |                                                                                                                                                                                                                                                      | -     | 0.36 |      |      |
| Total switching energy | $E_{ts}$     |                                                                                                                                                                                                                                                      | -     | 0.96 |      |      |

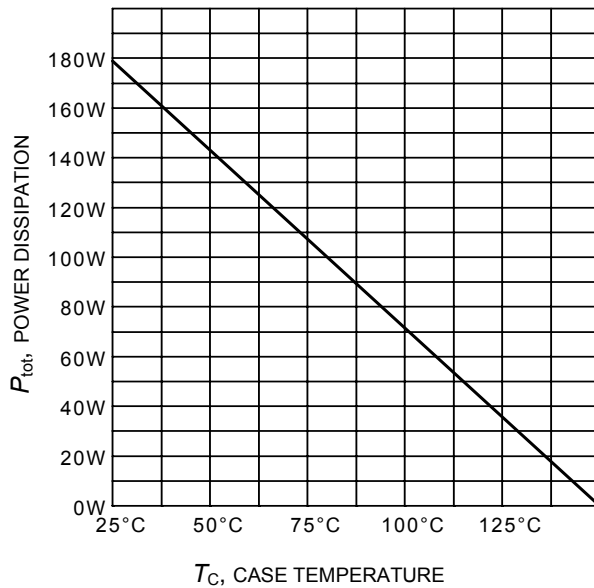
<sup>1)</sup> Leakage inductance  $L_{\sigma}$  and Stray capacity  $C_{\sigma}$  due to test circuit in Figure E.



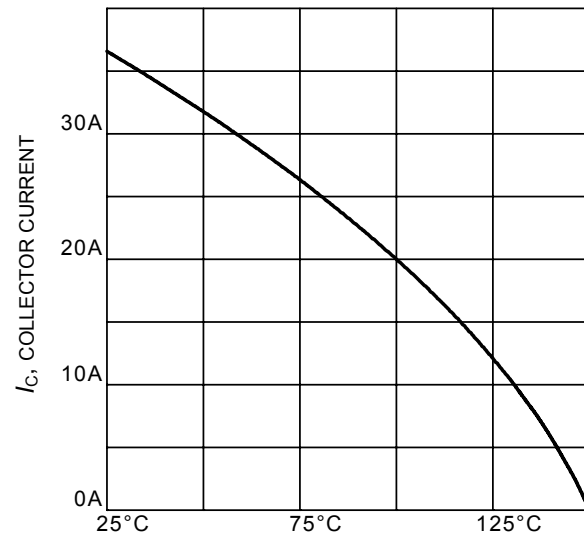
**Figure 1. Collector current as a function of switching frequency**  
 $(T_j \leq 150^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/+15\text{V}, R_G = 16\Omega)$



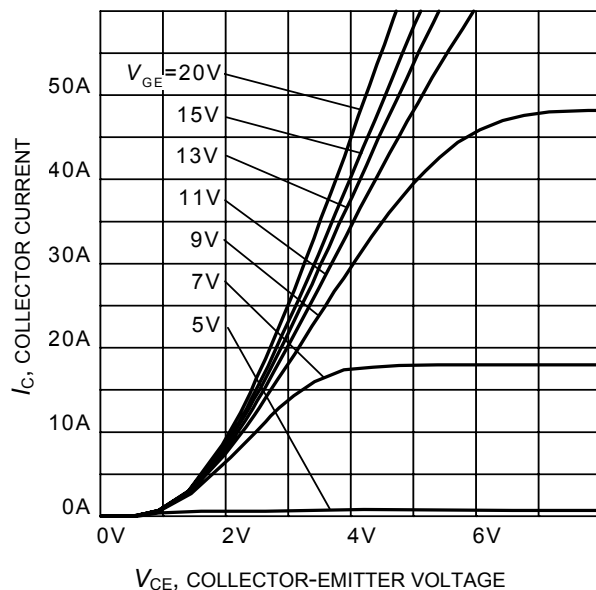
**Figure 2. Safe operating area**  
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 150^\circ\text{C}; V_{GE} = 15\text{V})$



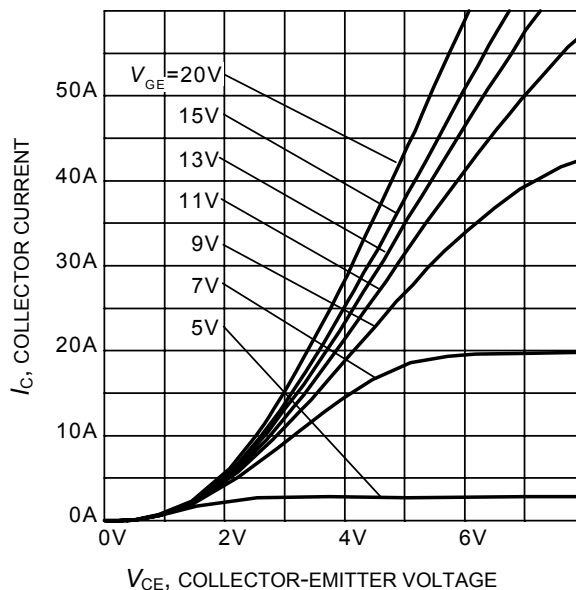
**Figure 3. Power dissipation as a function of case temperature**  
 $(T_j \leq 150^\circ\text{C})$



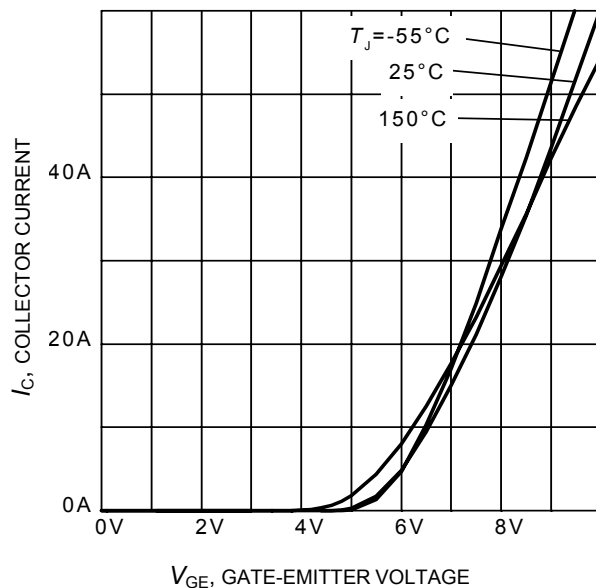
**Figure 4. Collector current as a function of case temperature**  
 $(V_{GE} \leq 15\text{V}, T_j \leq 150^\circ\text{C})$



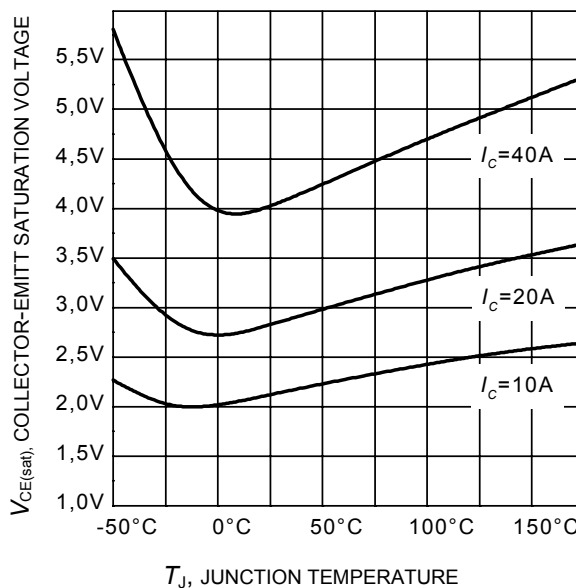
**Figure 5. Typical output characteristic**  
( $T_j = 25^\circ\text{C}$ )



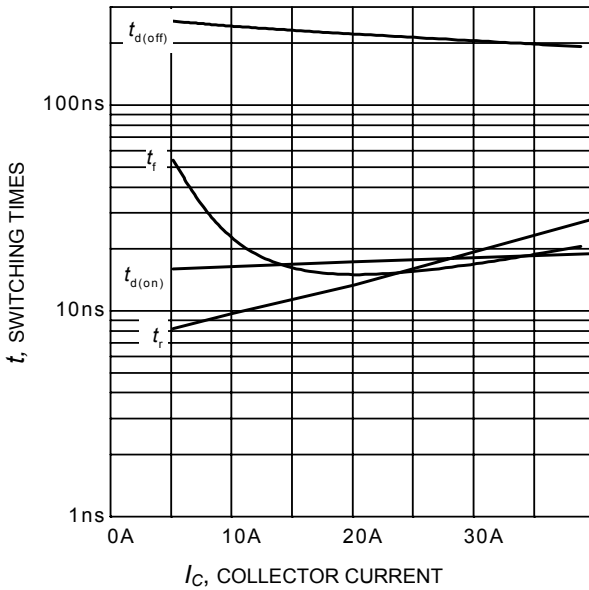
**Figure 6. Typical output characteristic**  
( $T_j = 150^\circ\text{C}$ )



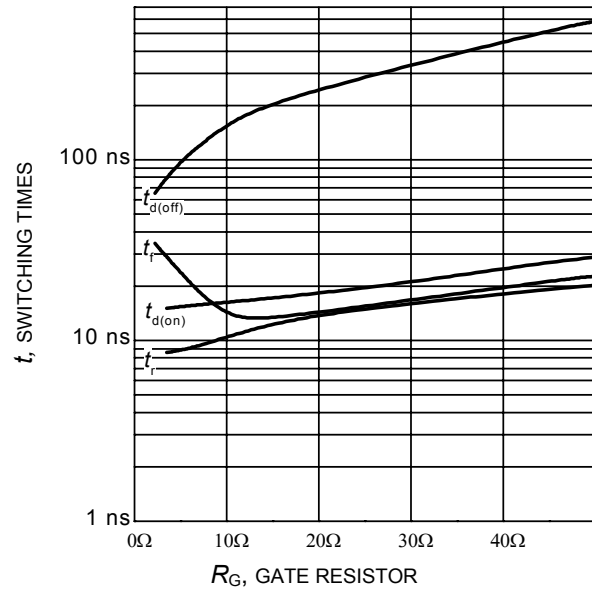
**Figure 7. Typical transfer characteristic**  
( $V_{ce} = 10\text{V}$ )



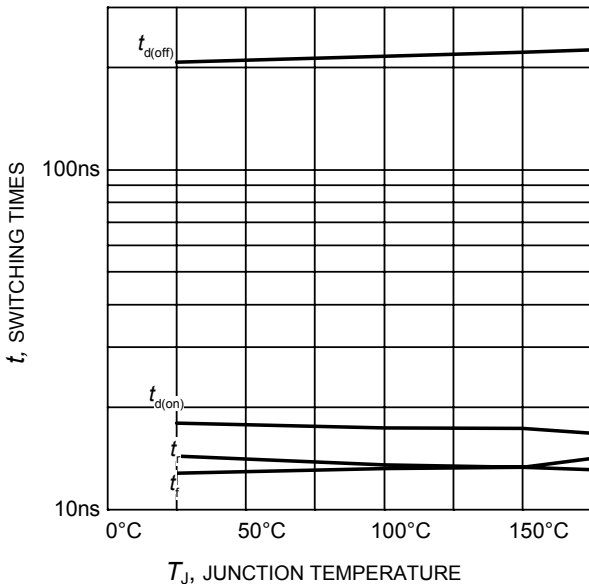
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{ge} = 15\text{V}$ )



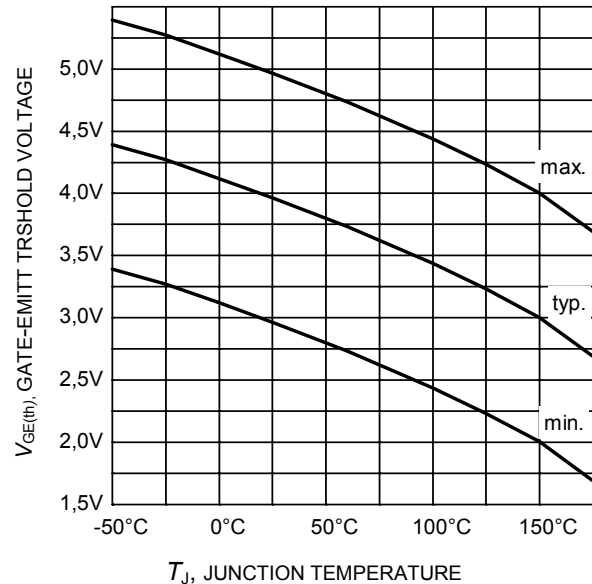
**Figure 9. Typical switching times as a function of collector current**  
(inductive load,  $T_J=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=16\Omega$ , Dynamic test circuit in Figure E)



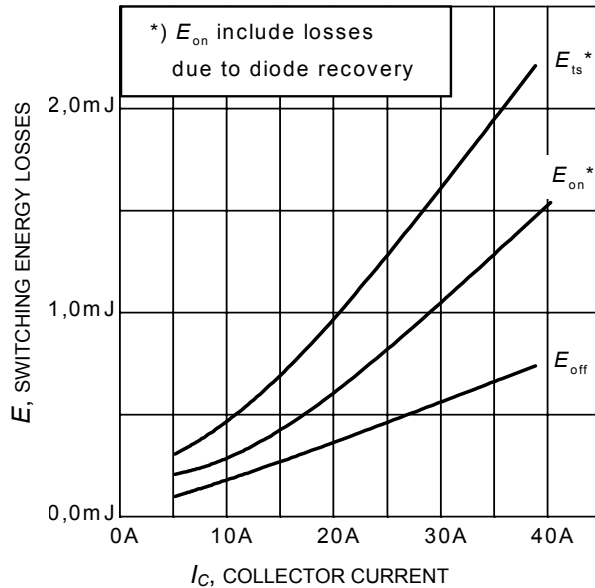
**Figure 10. Typical switching times as a function of gate resistor**  
(inductive load,  $T_J=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=20\text{A}$ , Dynamic test circuit in Figure E)



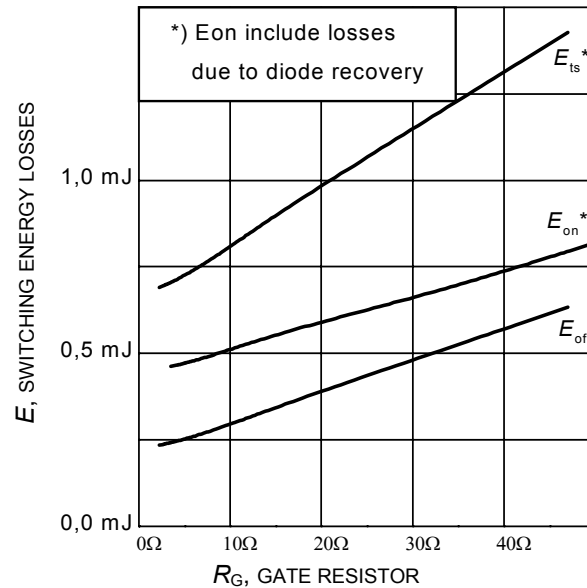
**Figure 11. Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=20\text{A}$ ,  $R_G=16\Omega$ , Dynamic test circuit in Figure E)



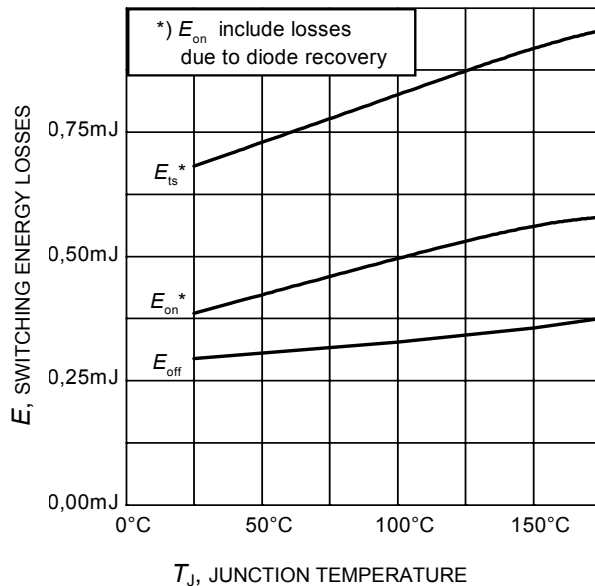
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C = 0.5\text{mA}$ )



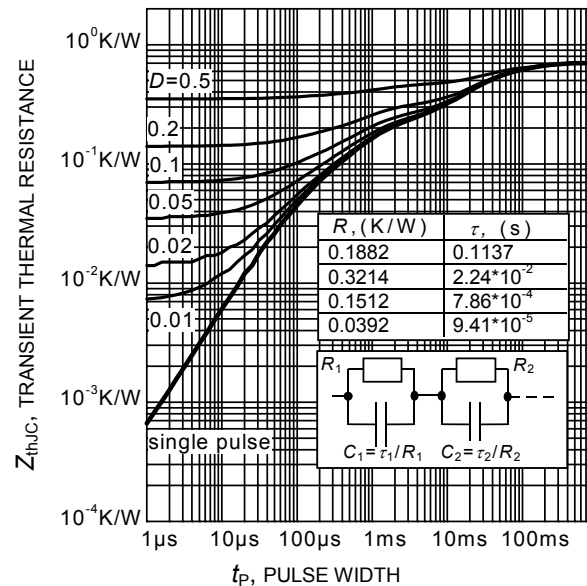
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_J=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=16\Omega$ , Dynamic test circuit in Figure E)



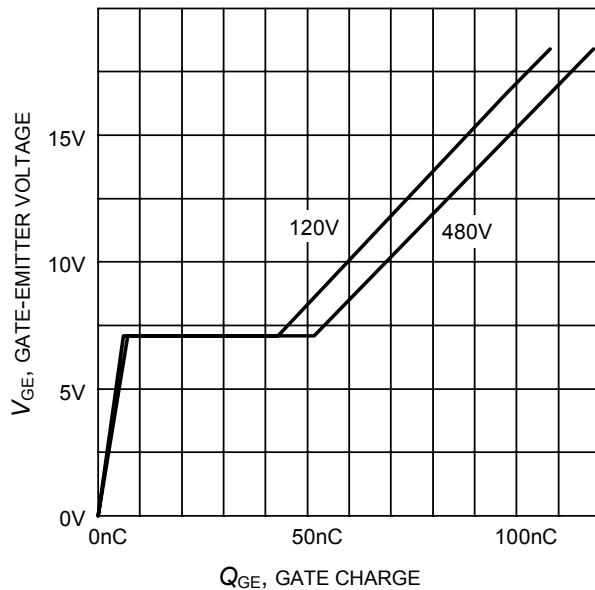
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_J=150^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=20\text{A}$ , Dynamic test circuit in Figure E)



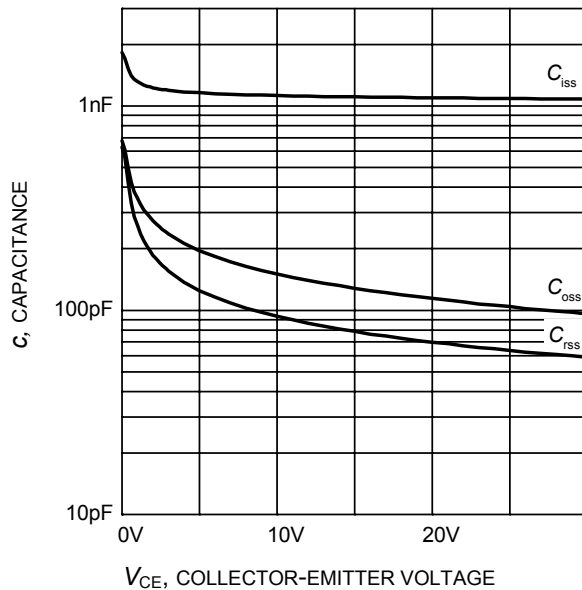
**Figure 15. Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=20\text{A}$ ,  $R_G=16\Omega$ , Dynamic test circuit in Figure E)



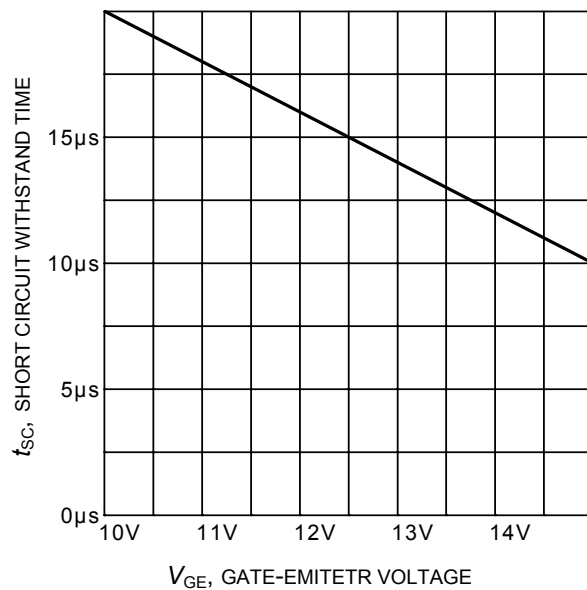
**Figure 16. IGBT transient thermal resistance**  
( $D = t_p / T$ )



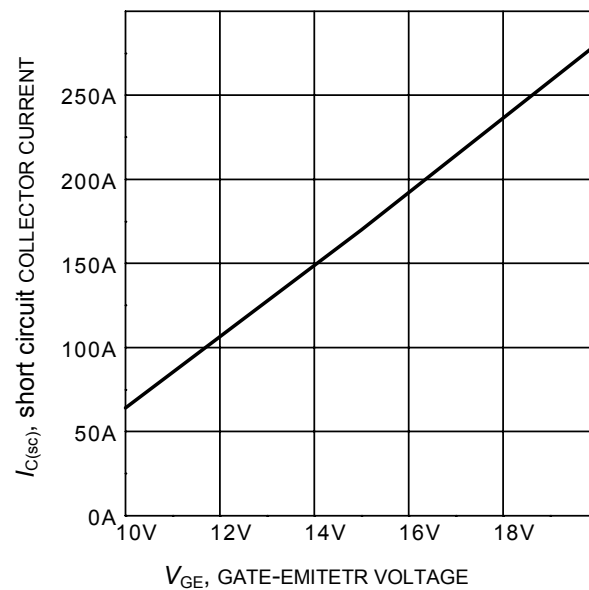
**Figure 17. Typical gate charge**  
( $I_C=20\text{ A}$ )



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



**Figure 19. Short circuit withstand time as a function of gate-emittetr voltage**  
( $V_{CE}=600V$ , start at  $T_J=25^\circ\text{C}$ )



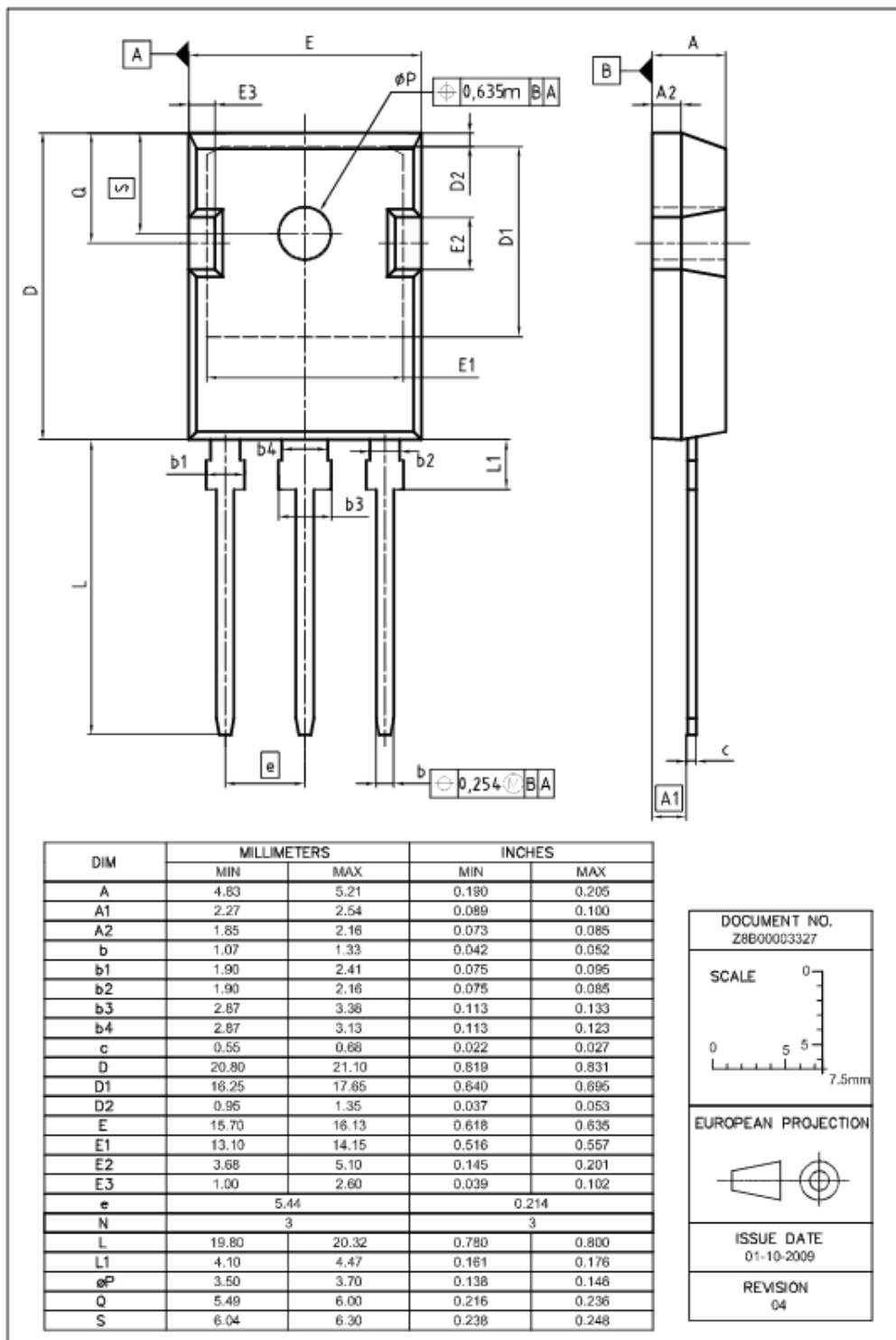
**Figure 20. Typical short circuit collector current as a function of gate-emittetr voltage**  
( $V_{CE} \leq 600V$ ,  $T_J \leq 150^\circ\text{C}$ )

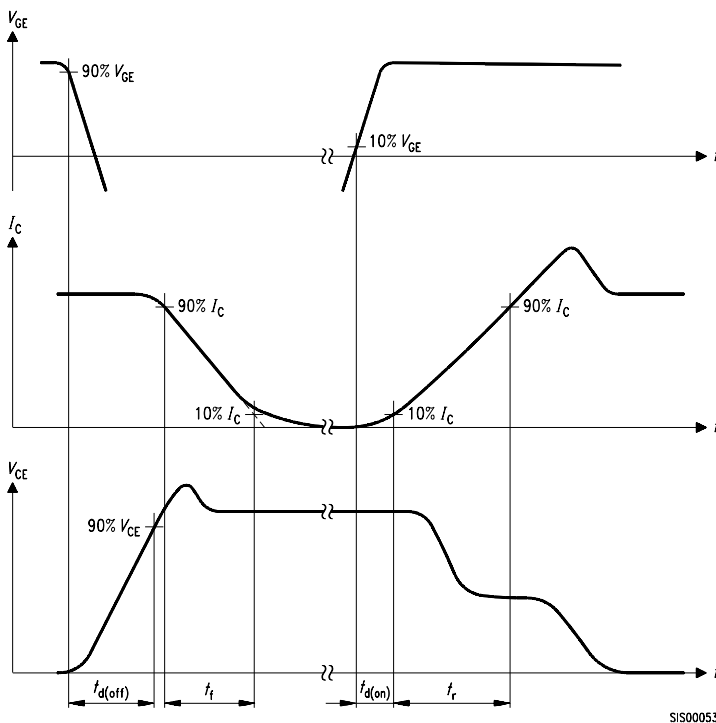




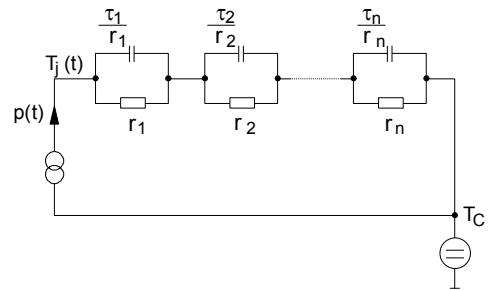
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| DOCUMENT NO.<br>Z8B00003318 |  |
| SCALE                       |  |
| EUROPEAN PROJECTION         |  |
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| ISSUE DATE<br>23-08-2007    |  |
| REVISION<br>05              |  |

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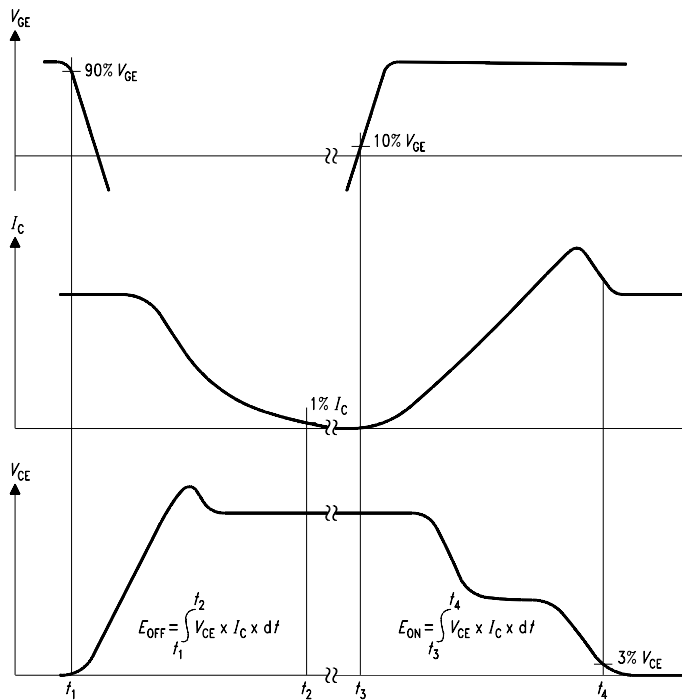




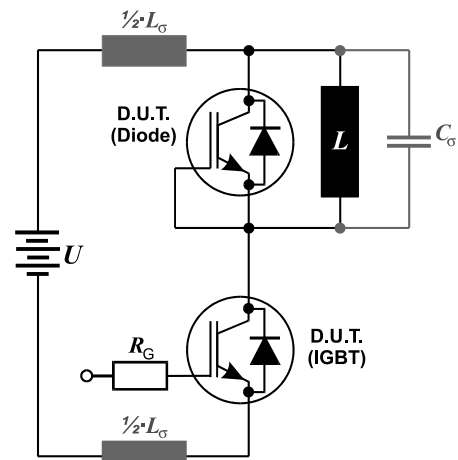
**Figure A. Definition of switching times**



**Figure D. Thermal equivalent circuit**



**Figure B. Definition of switching losses**



**Figure E. Dynamic test circuit**  
Leakage inductance  $L_{\sigma} = 60\text{nH}$   
and Stray capacity  $C_{\sigma} = 40\text{pF}$ .

**Published by**  
**Infineon Technologies AG**  
**81726 Munich, Germany**  
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