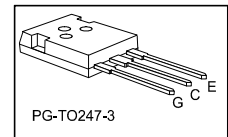
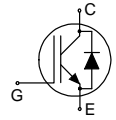


## Reverse conducting IGBT

### Features:

- Powerful monolithic body diode with low forward voltage designed for soft commutation only
- TrenchStop® technology applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - low  $V_{CEsat}$
  - easy parallel switching capability due to positive temperature coefficient in  $V_{CEsat}$
- Low EMI
- Qualified according to JEDEC J-STD-020 and JESD-022 for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>



### Applications:

- Inductive cooking

| Type      | $V_{CE}$ | $I_C$ | $V_{CEsat}, T_{vj}=25^{\circ}C$ | $T_{vjmax}$ | Marking | Package    |
|-----------|----------|-------|---------------------------------|-------------|---------|------------|
| IHW40N60R | 600V     | 40A   | 1.65V                           | 175°C       | H40R60  | PG-TO247-3 |

### Maximum ratings

| Parameter  | Symbol      | Value          | Unit |
|--|-------------|----------------|------|
| Collector-emitter voltage  | $V_{CE}$    | 600            | V    |
| DC collector current, limited by $T_{vjmax}$<br>$T_C = 25^{\circ}C$<br>$T_C = 100^{\circ}C$  | $I_C$       | 80.0<br>40.0   | A    |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$                                       | $I_{Cpuls}$ | 120.0          | A    |
| Turn off safe operating area $V_{CE} = 600V, T_{vj} = 175^{\circ}C$                          | -           | 120.0          | A    |
| Diode forward current, limited by $T_{vjmax}$<br>$T_C = 25^{\circ}C$<br>$T_C = 100^{\circ}C$ | $I_F$       | 80.0<br>40.0   | A    |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$   | $I_{Fpuls}$ | 120.0          | A    |
| Gate-emitter voltage   | $V_{GE}$    | $\pm 20$       | V    |
| Power dissipation $T_C = 25^{\circ}C$<br>Power dissipation $T_C = 100^{\circ}C$              | $P_{tot}$   | 305.0<br>152.5 | W    |
| Operating junction temperature   | $T_{vj}$    | -40...+175     | °C   |
| Storage temperature  | $T_{stg}$   | -55...+175     | °C   |
| Soldering temperature,<br>wavesoldering 1.6 mm (0.063 in.) from case for 10s                 |             | 260            | °C   |
| Mounting torque, M3 screw<br>Maximum of mounting processes: 3                                | $M$         | 0.6            | Nm   |

**Thermal Resistance**

| Parameter                                 | Symbol        | Conditions | Max. Value | Unit |
|---|---------------|------------|------------|------|
| <b>Characteristic</b>                     |               |            |            |      |
| IGBT thermal resistance, junction - case  | $R_{th(j-c)}$ |            | 0.49       | K/W  |
| Diode thermal resistance, junction - case | $R_{th(j-c)}$ |            | 0.49       | K/W  |
| Thermal resistance junction - ambient     | $R_{th(j-a)}$ |            | 40         | K/W  |

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

| Parameter                            | Symbol        | Conditions   | Value  |              |                | Unit          |
|--------------------------------------|---------------|--|--------|--------------|----------------|---------------|
|                                      |               |  | min.   | typ.         | max.           |               |
| <b>Static Characteristic</b>         |               |  |        |              |                |               |
| Collector-emitter breakdown voltage  | $V_{(BR)CES}$ | $V_{GE} = 0V, I_C = 0.50mA$  | 600    | -            | -              | V             |
| Collector-emitter saturation voltage | $V_{CEsat}$   | $V_{GE} = 15.0V, I_C = 40.0A$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$ | -<br>- | 1.65<br>2.10 | 2.05<br>-      | V             |
| Diode forward voltage                | $V_F$         | $V_{GE} = 0V, I_F = 40.0A$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$    | -<br>- | 1.65<br>1.90 | 2.05           | V             |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $I_C = 0.58mA, V_{CE} = V_{GE}$  | 4.1    | 4.9          | 5.7            | V             |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE} = 600V, V_{GE} = 0V$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$  | -<br>- | -<br>-       | 40.0<br>1000.0 | $\mu\text{A}$ |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{CE} = 0V, V_{GE} = 20V$  | -      | -            | 100            | nA            |
| Transconductance                     | $g_{fs}$      | $V_{CE} = 20V, I_C = 40.0A$  | -      | 19.0         | -              | S             |
| Integrated gate resistor             | $r_G$         |  |        | none         |                | $\Omega$      |

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

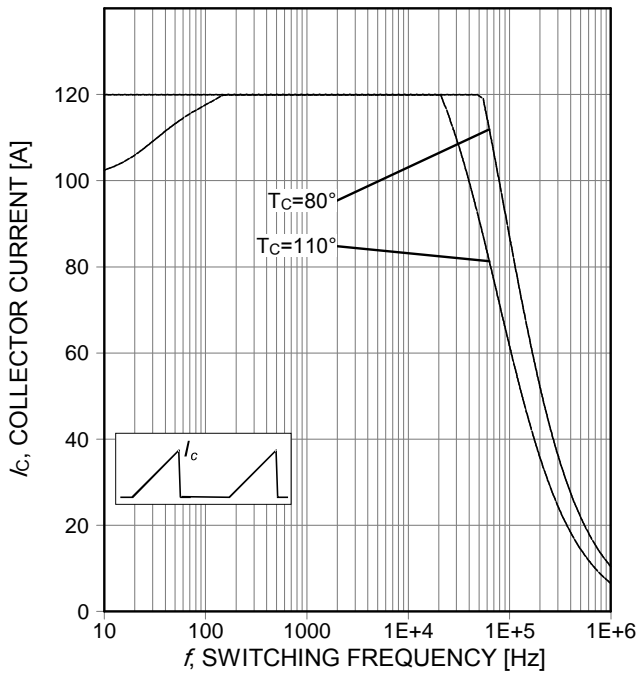
| Parameter  | Symbol    | Conditions                                      | Value |       |      | Unit |
|--|-----------|---|-------|-------|------|------|
|  |           |   | min.  | typ.  | max. |      |
| <b>Dynamic Characteristic</b>                                  |           |   |       |       |      |      |
| Input capacitance  | $C_{ies}$ | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$           | -     | 2370  | -    | pF   |
| Output capacitance   | $C_{oes}$ |   | -     | 81    | -    |      |
| Reverse transfer capacitance                                   | $C_{res}$ |   | -     | 63    | -    |      |
| Gate charge  | $Q_G$     | $V_{CC} = 480V, I_C = 40.0A,$<br>$V_{GE} = 15V$ | -     | 223.0 | -    | nC   |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$     |   | -     | 13.0  | -    | nH   |

**Switching Characteristic, Inductive Load, at  $T_{vj} = 25^{\circ}\text{C}$** 

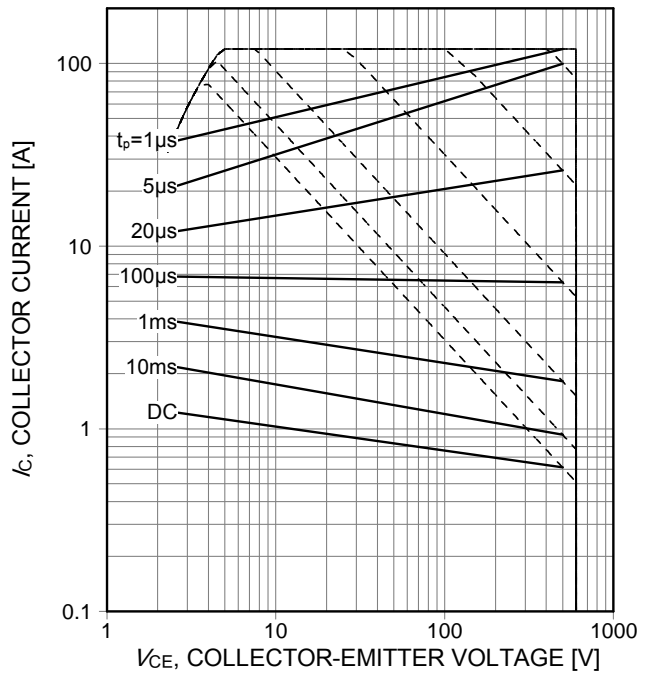
| Parameter                  | Symbol       | Conditions   | Value |      |      | Unit |
|----------------------------|--------------|--|-------|------|------|------|
|                            |              |  | min.  | typ. | max. |      |
| <b>IGBT Characteristic</b> |              |  |       |      |      |      |
| Turn-off delay time        | $t_{d(off)}$ | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$r_G = 5.6\Omega$ , $L_{\sigma} = 90\text{nH}$ ,<br>$C_{\sigma} = 67\text{pF}$<br>$L_{\sigma}$ , $C_{\sigma}$ from Fig. E<br>Energy losses include "tail" and diode reverse recovery. | -     | 193  | -    | ns   |
| Fall time                  | $t_f$        |  | -     | 24   | -    | ns   |
| Turn-off energy            | $E_{off}$    |  | -     | 0.75 | -    | mJ   |

**Switching Characteristic, Inductive Load, at  $T_{vj} = 175^{\circ}\text{C}$** 

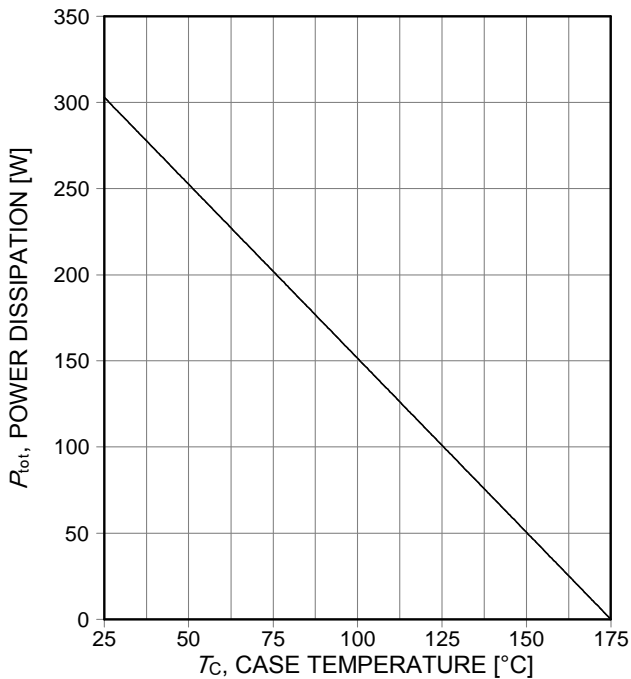
| Parameter                  | Symbol       | Conditions  | Value |      |      | Unit |
|----------------------------|--------------|---|-------|------|------|------|
|                            |              |   | min.  | typ. | max. |      |
| <b>IGBT Characteristic</b> |              |   |       |      |      |      |
| Turn-off delay time        | $t_{d(off)}$ | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$r_G = 5.6\Omega$ , $L_{\sigma} = 90\text{nH}$ ,<br>$C_{\sigma} = 67\text{pF}$<br>$L_{\sigma}$ , $C_{\sigma}$ from Fig. E<br>Energy losses include "tail" and diode reverse recovery. | -     | 227  | -    | ns   |
| Fall time                  | $t_f$        |   | -     | 37   | -    | ns   |
| Turn-off energy            | $E_{off}$    |   | -     | 1.22 | -    | mJ   |



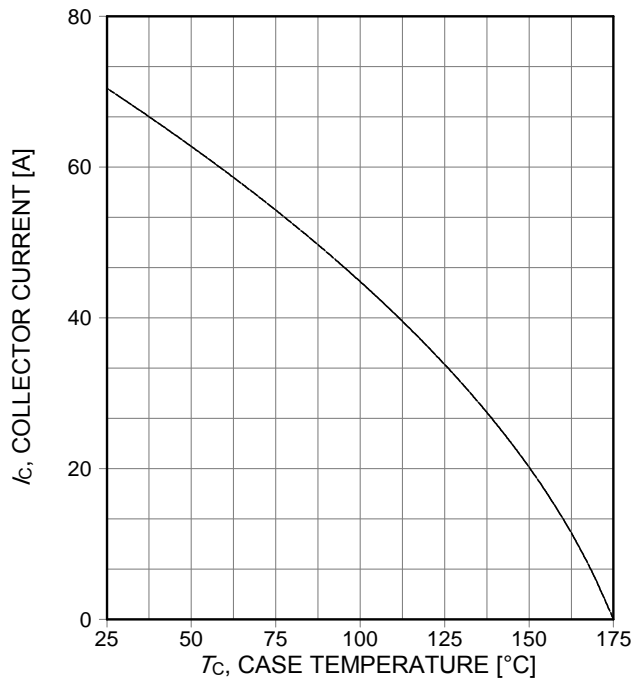
**Figure 1. Collector current as a function of switching frequency**  
 ( $T_j \leq 175^\circ\text{C}$ ,  $D=0.5$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $R_G=5.6\Omega$ )



**Figure 2. Forward bias safe operating area**  
 ( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_j \leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ )



**Figure 3. Power dissipation as a function of case temperature**  
 ( $T_j \leq 175^\circ\text{C}$ )



**Figure 4. Collector current as a function of case temperature**  
 ( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 175^\circ\text{C}$ )

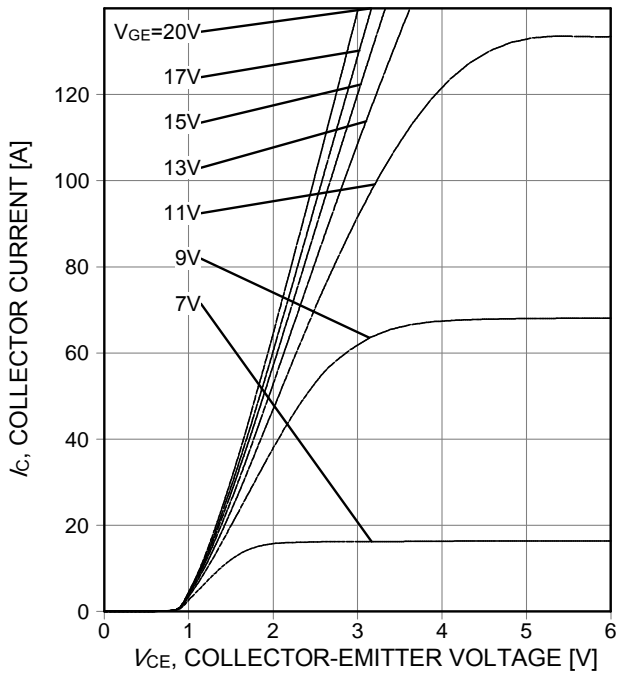


Figure 5. Typical output characteristic ( $T_j=25^\circ\text{C}$ )

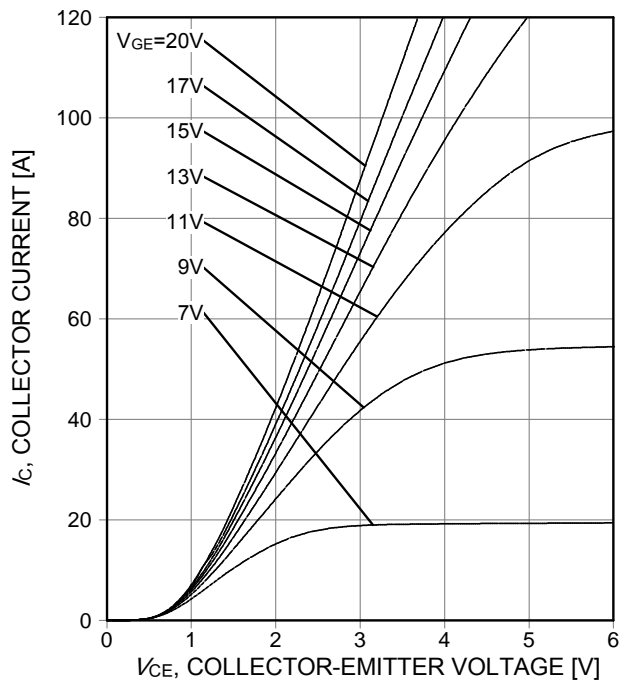


Figure 6. Typical output characteristic ( $T_j=175^\circ\text{C}$ )

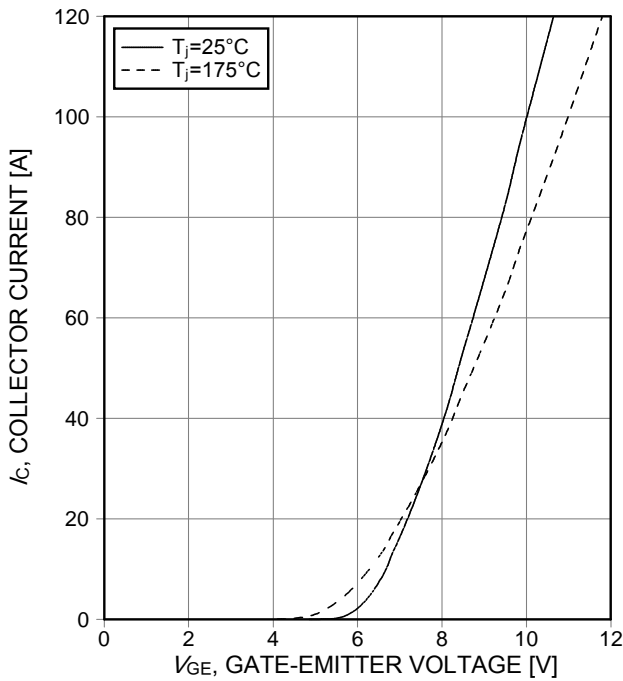


Figure 7. Typical transfer characteristic ( $V_{CE}=20\text{V}$ )

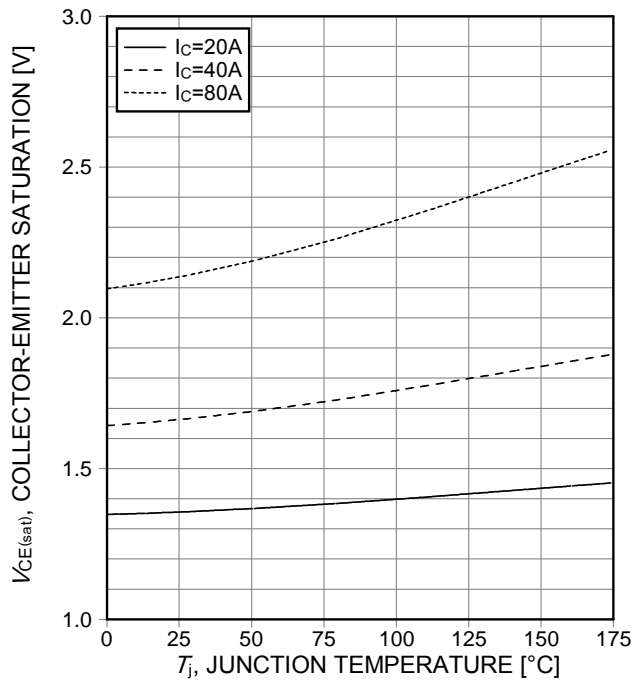
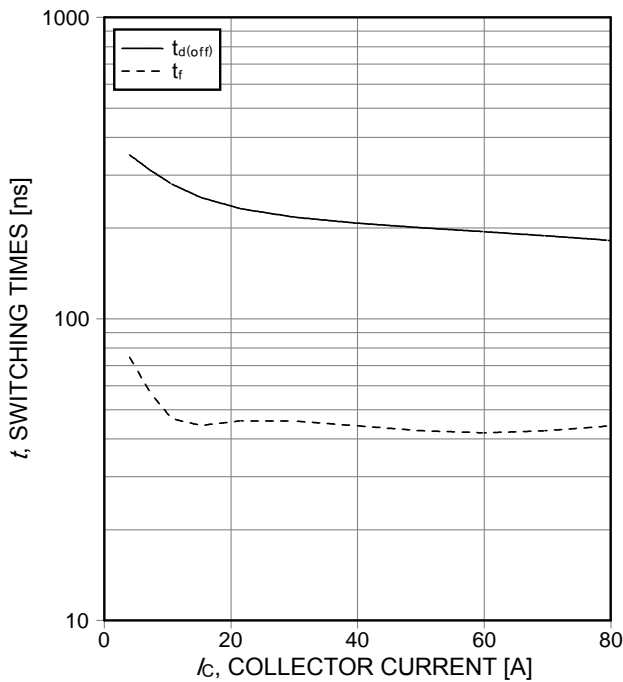
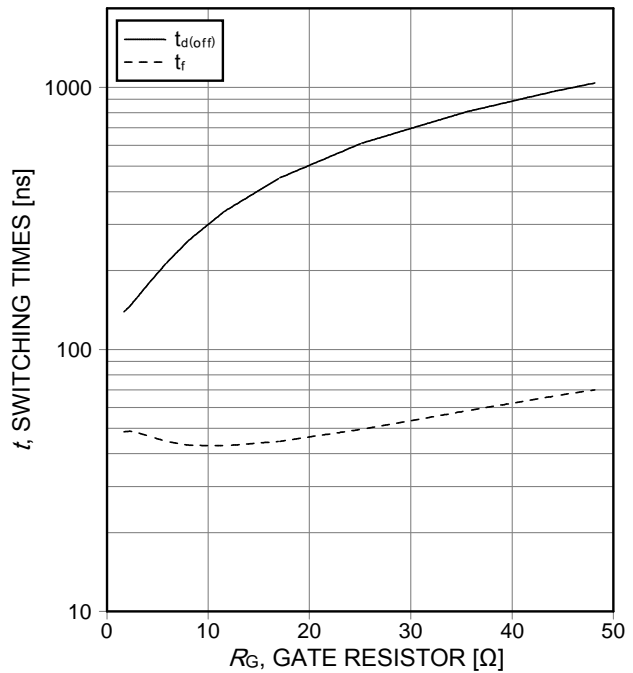


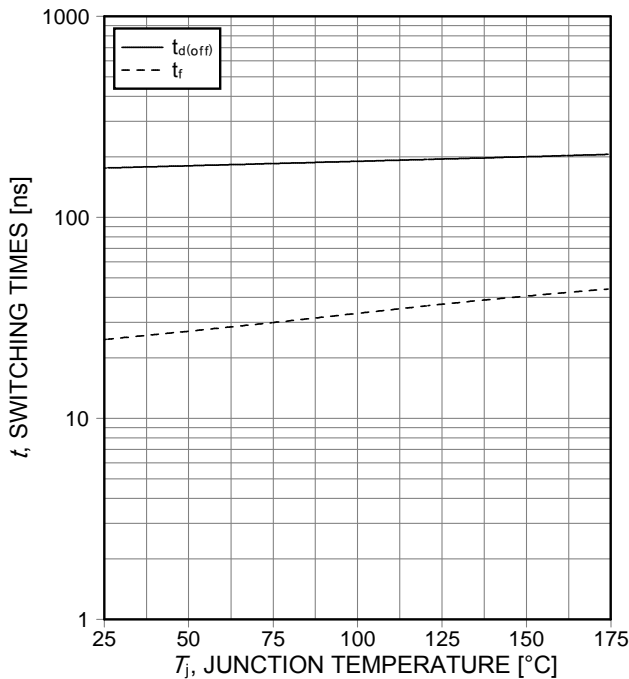
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15\text{V}$ )



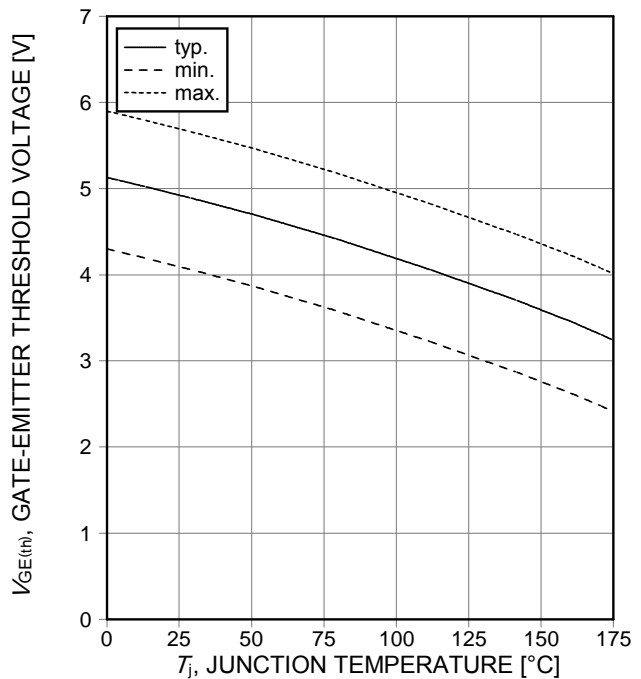
**Figure 9. Typical switching times as a function of collector current**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $R_G=5.6\Omega$ , Dynamic test circuit in Figure E)



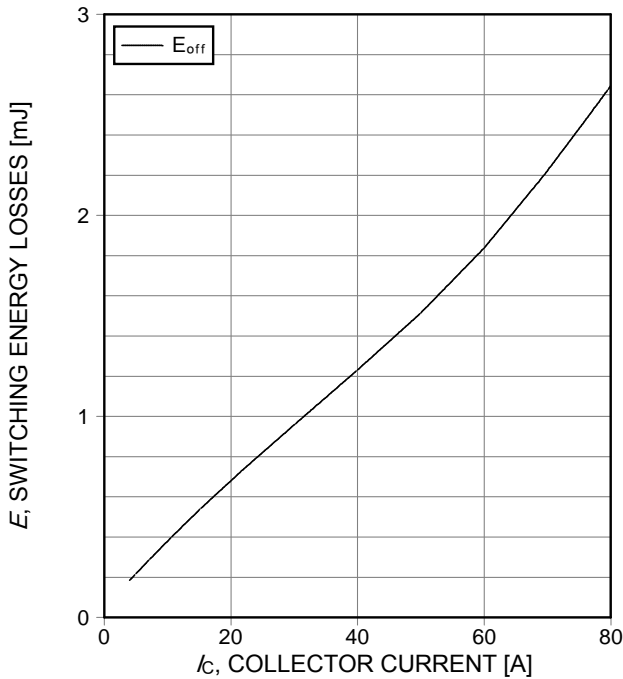
**Figure 10. Typical switching times as a function of gate resistor**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)



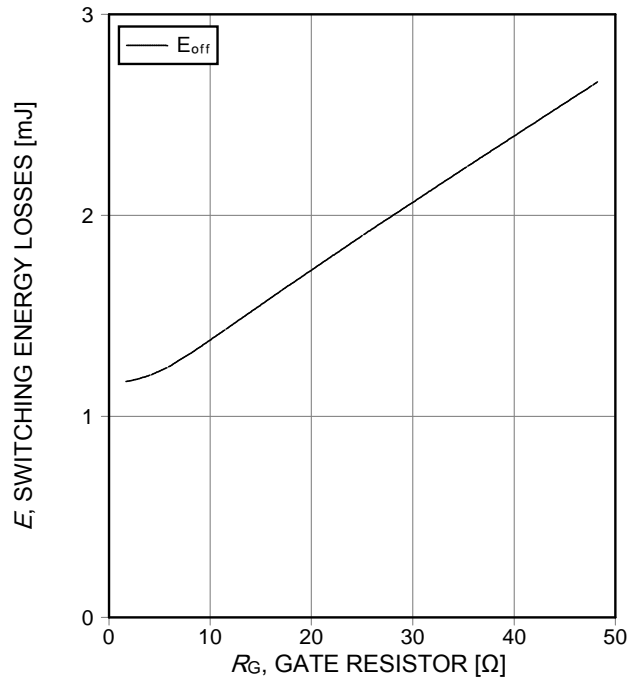
**Figure 11. Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=5.6\Omega$ , Dynamic test circuit in Figure E)



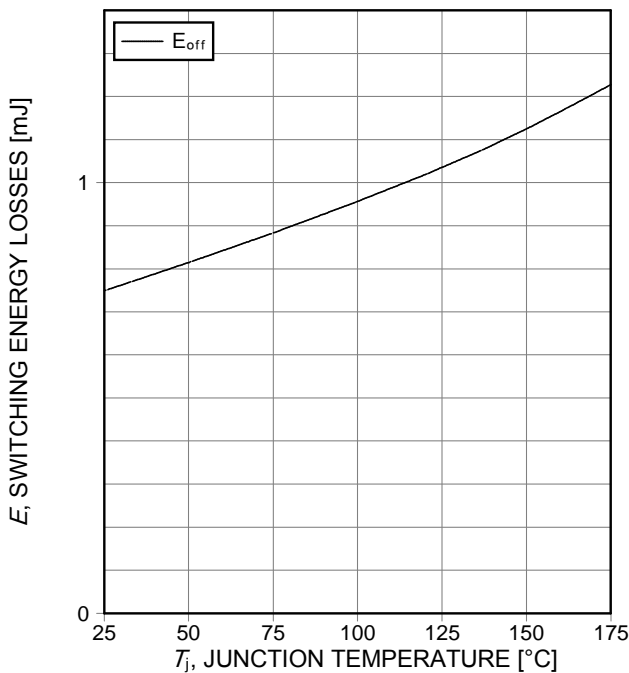
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C=0.6\text{mA}$ )



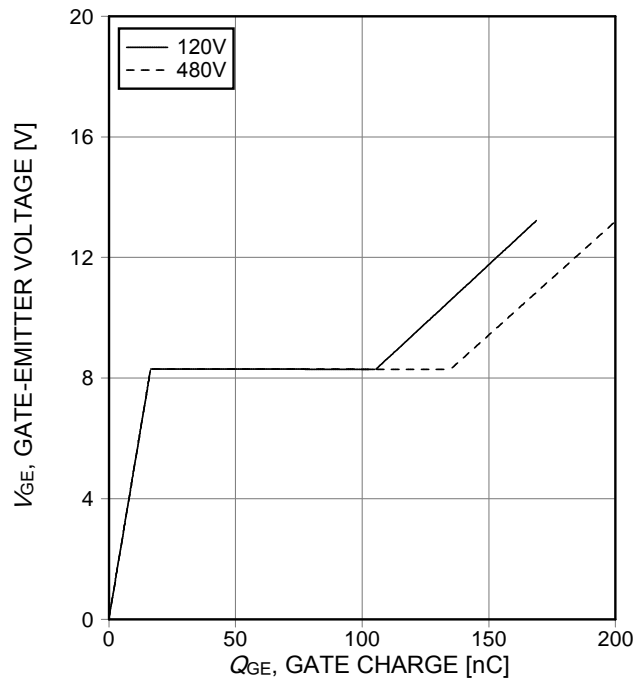
**Figure 13. Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $R_G=5.6\Omega$ , Dynamic test circuit in Figure E)



**Figure 14. Typical switching energy losses as a function of gate resistor**  
 (inductive load,  $T_j=175^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $I_c=40\text{A}$ ,  $V_{GE}=15/0\text{V}$ , Dynamic test circuit in Figure E)



**Figure 15. Typical switching energy losses as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_c=40\text{A}$ ,  $R_G=5.6\Omega$ , Dynamic test circuit in Figure E)



**Figure 16. Typical gate charge**  
 ( $I_c=40\text{A}$ )

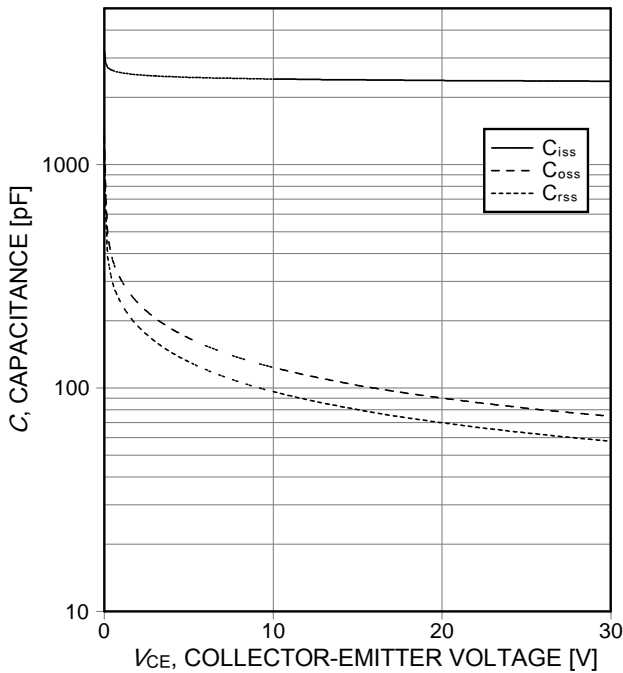


Figure 17. Typical capacitance as a function of collector-emitter voltage ( $V_{GE}=0V$ ,  $f=1MHz$ )

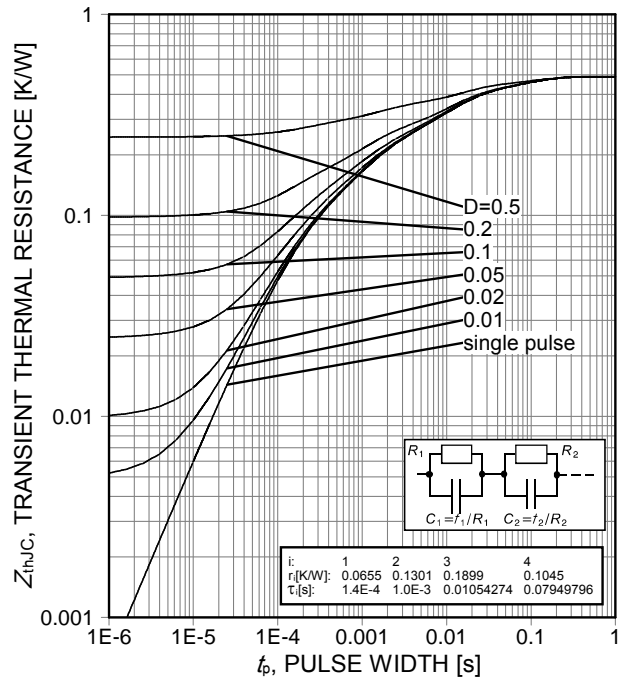


Figure 18. IGBT transient thermal resistance ( $D=t_p/T$ )

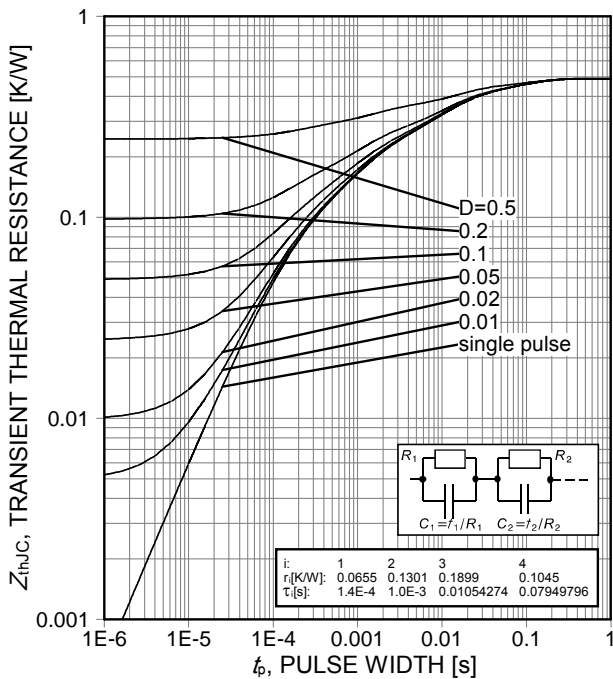


Figure 19. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

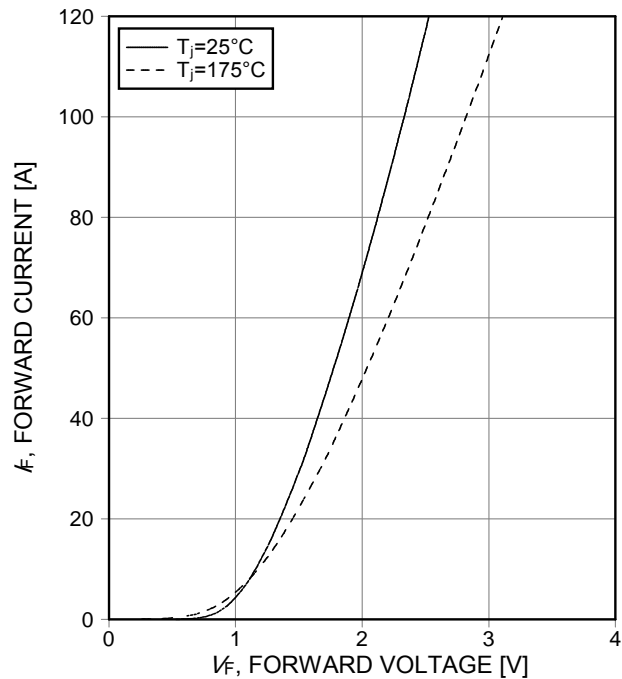


Figure 20. Typical diode forward current as a function of forward voltage



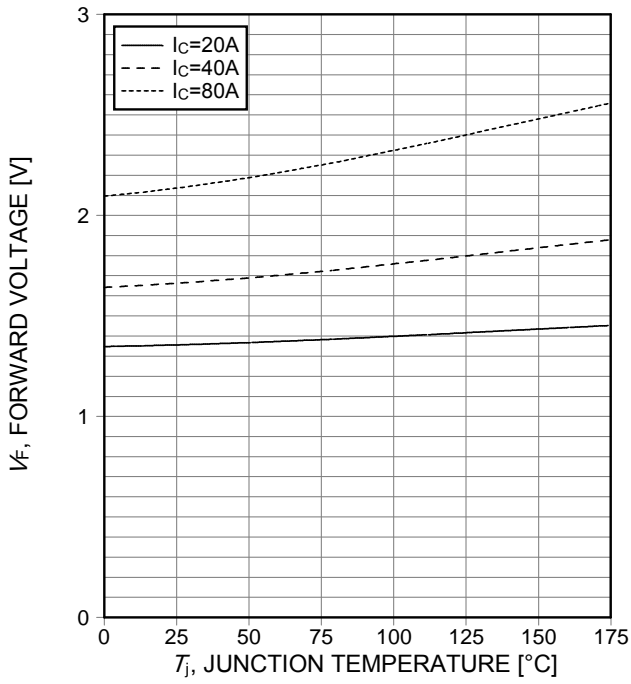
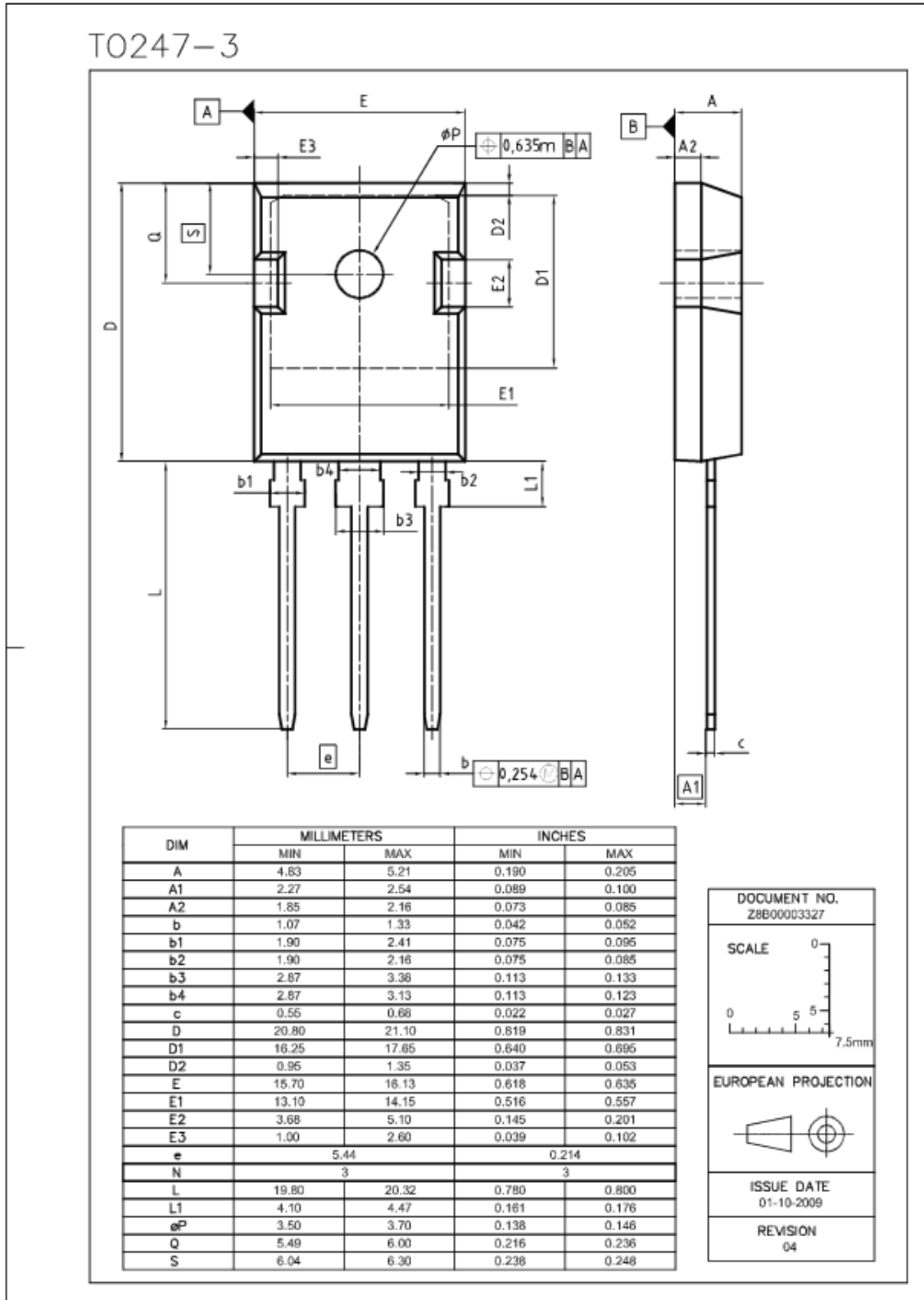


Figure 21. Typical diode forward voltage as a function of junction temperature

PG-TO247-3



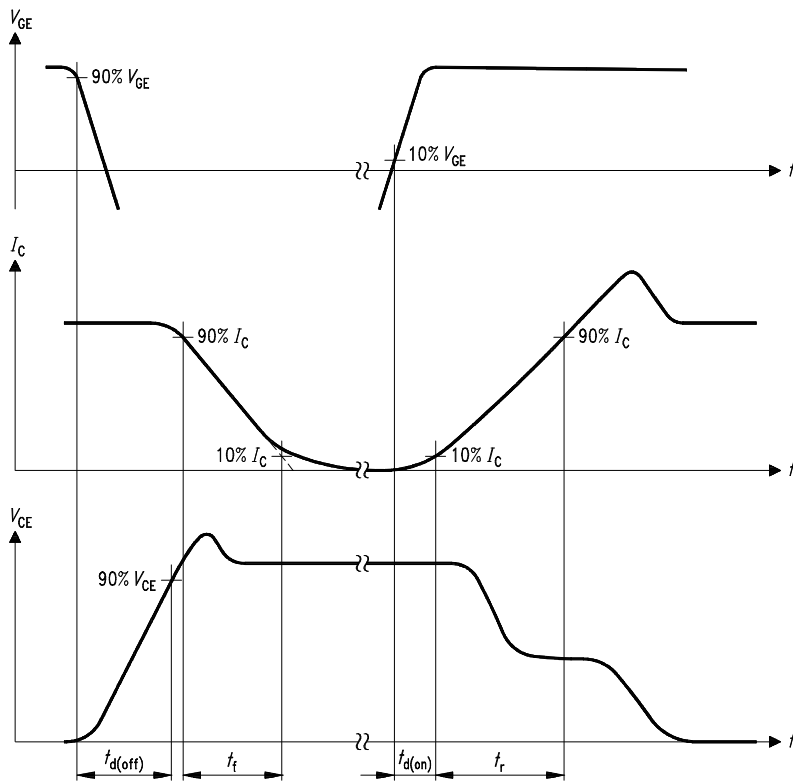


Figure A. Definition of switching times

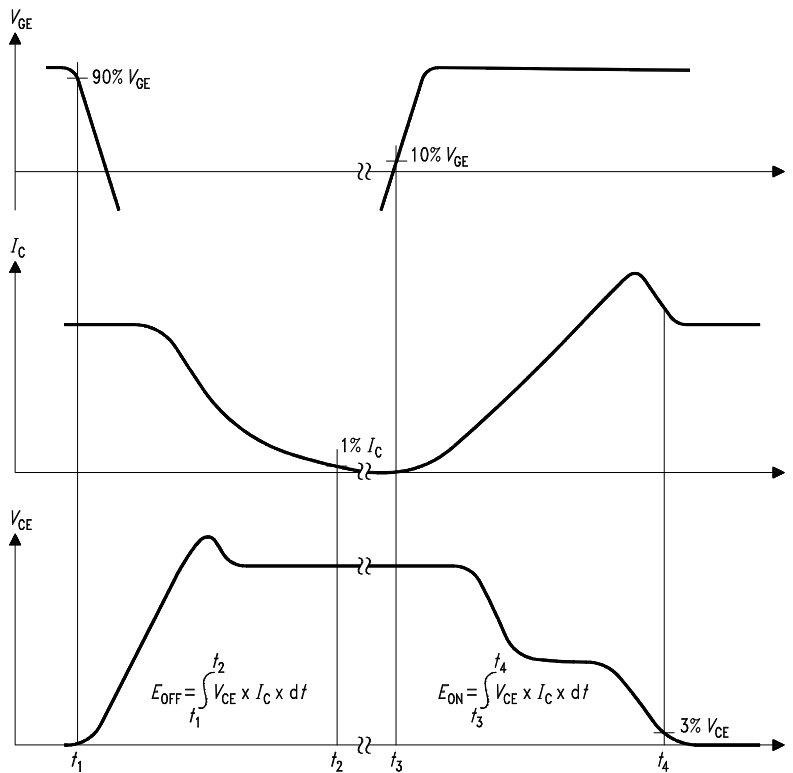


Figure B. Definition of switching losses

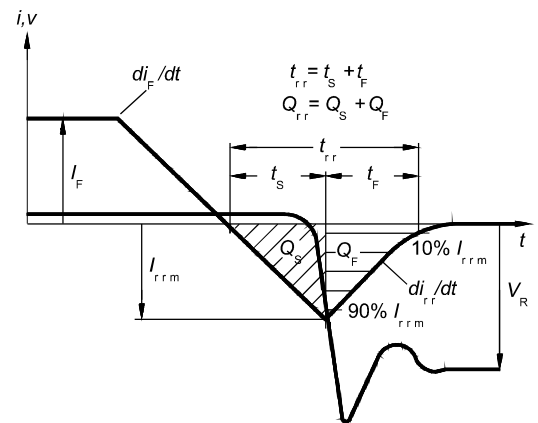


Figure C. Definition of diodes switching characteristics

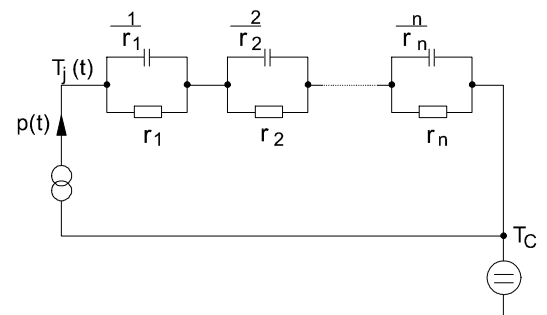


Figure D. Thermal equivalent circuit

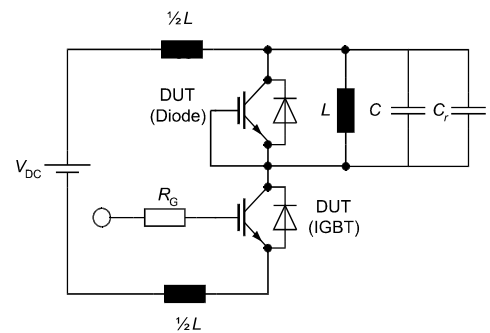


Figure E. Dynamic test circuit  
 Leakage inductance  $L = 180\text{nH}$ ,  
 Stray capacitor  $C_s = 40\text{pF}$ ,  
 Relief capacitor  $C_r = 1\text{nF}$   
 (only for ZVT switching)

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